Lo studio eco-color-doppler del circolo anteriore: dalle carotidi extracraniche al circolo di Willis

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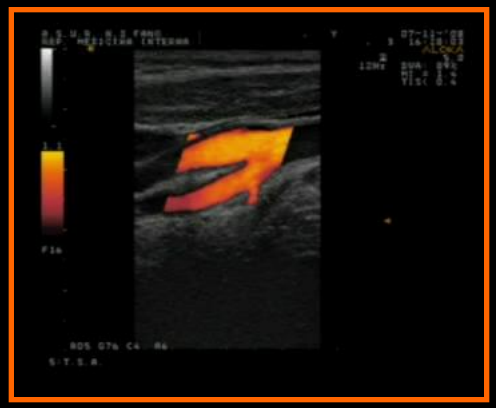
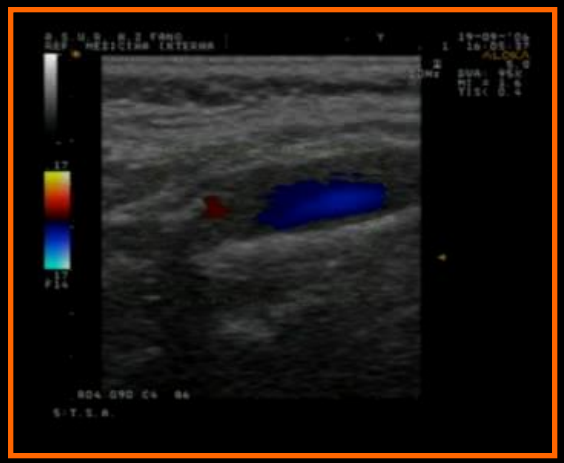
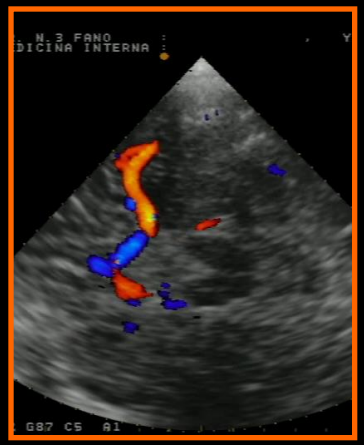
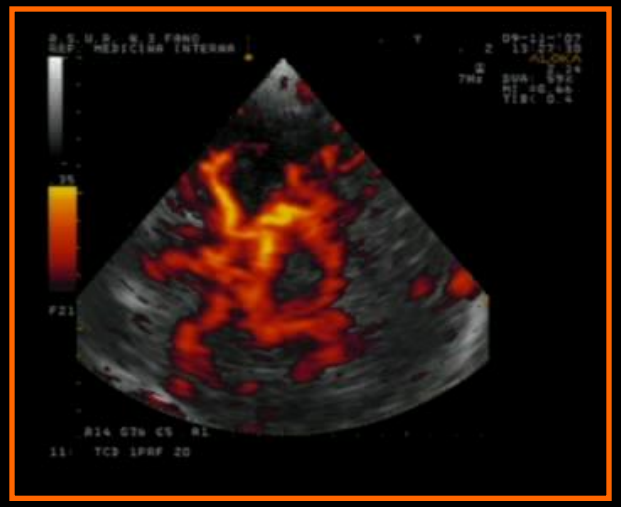
Dir. Resp. Dr. G. Frausini

Lo studio eco-color-doppler del circolo anteriore: dalle carotidi extracraniche al circolo d Willis

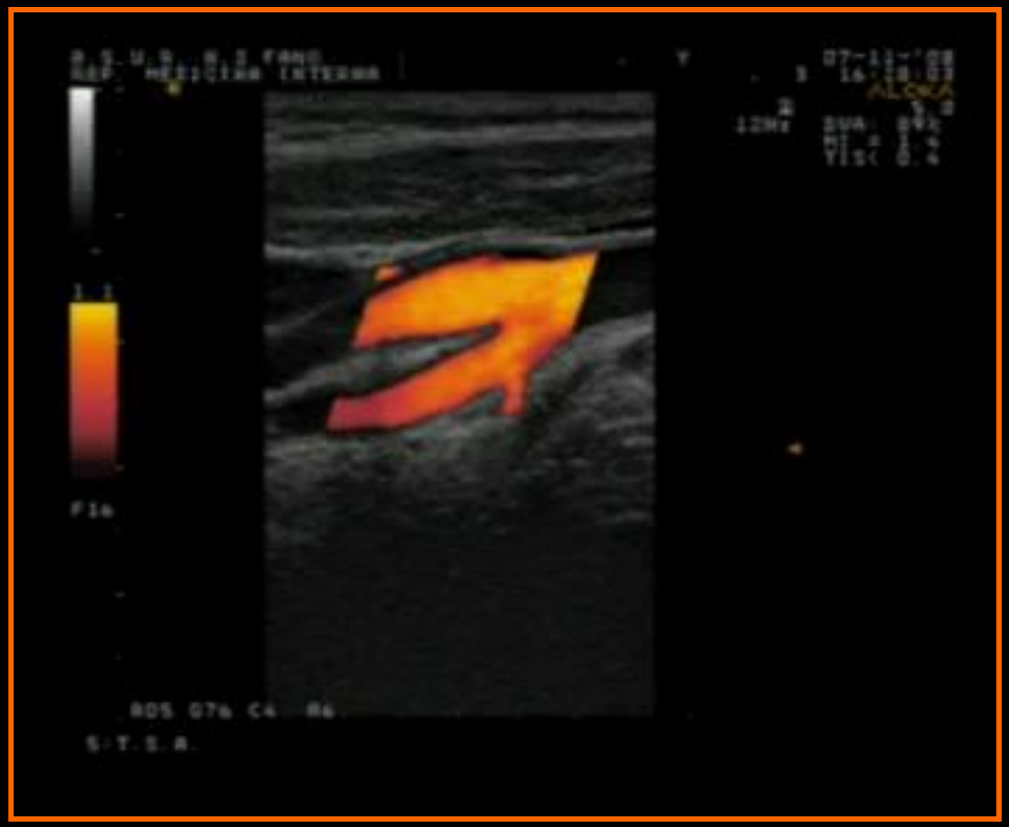


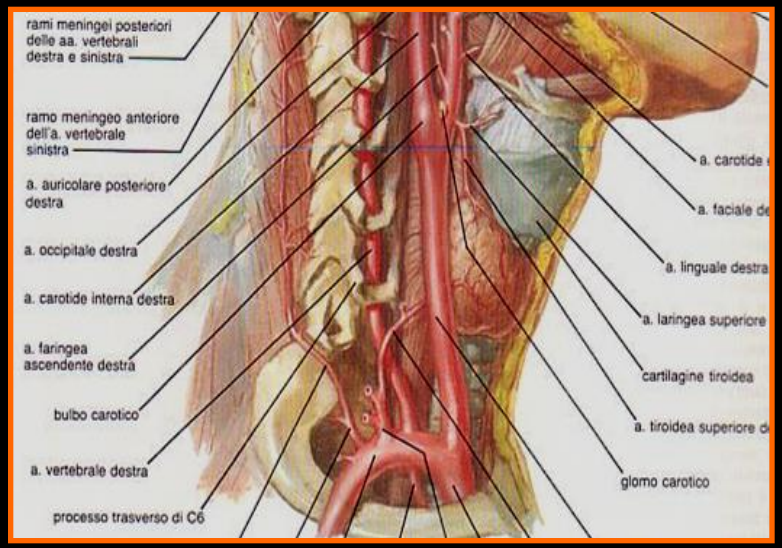






Eco-color-doppler
Tronchi Sopra-Aortici





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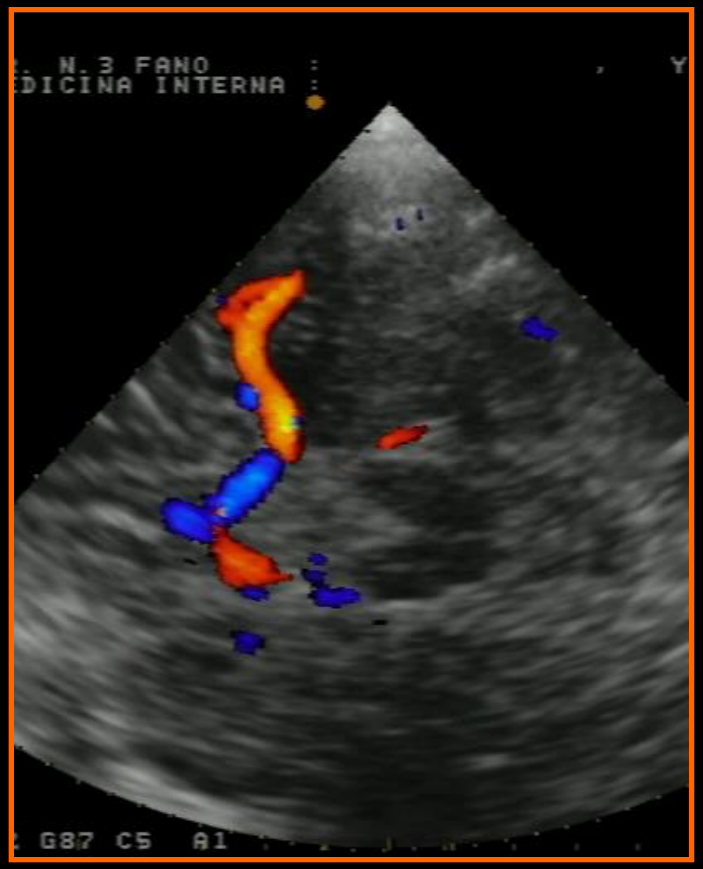
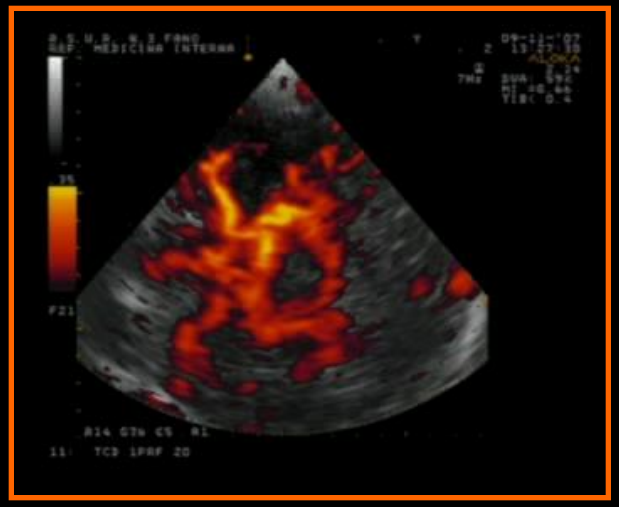
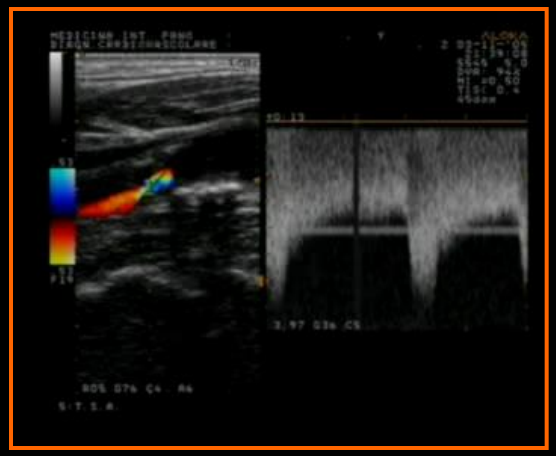
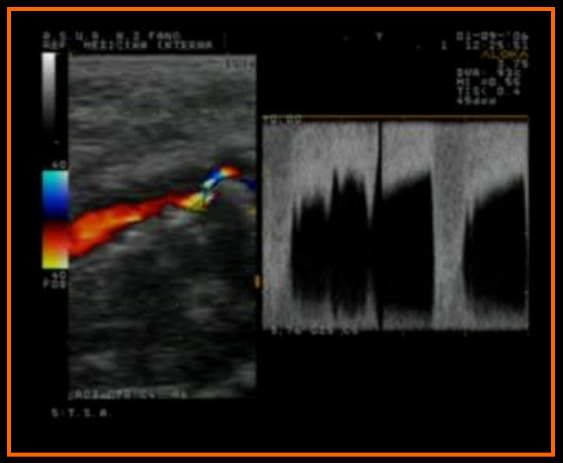




Stenosi carotide interna





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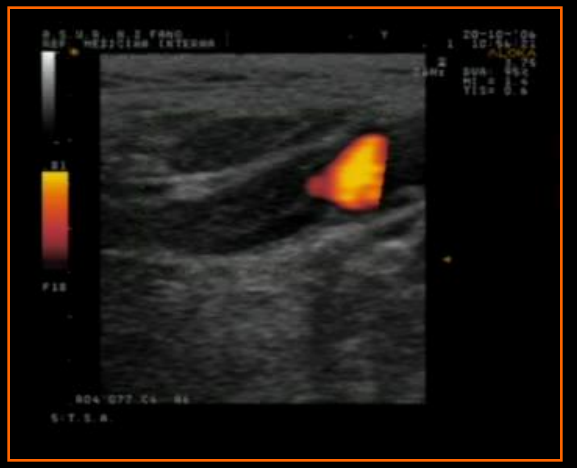
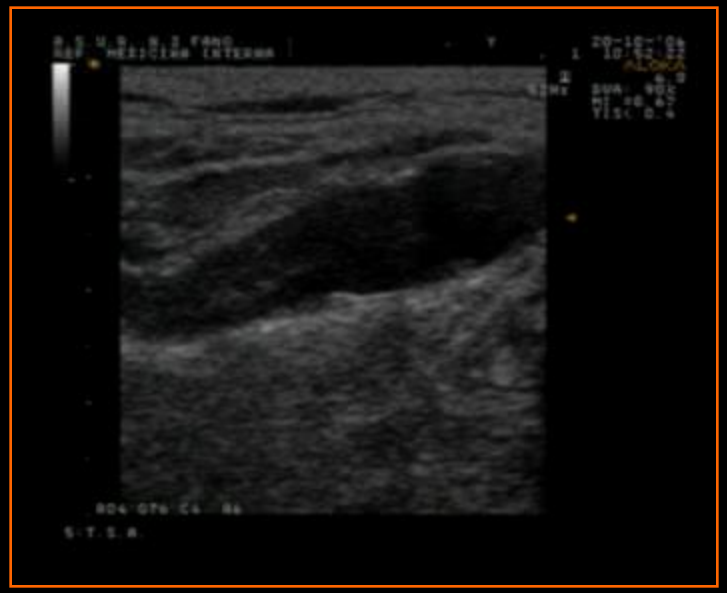
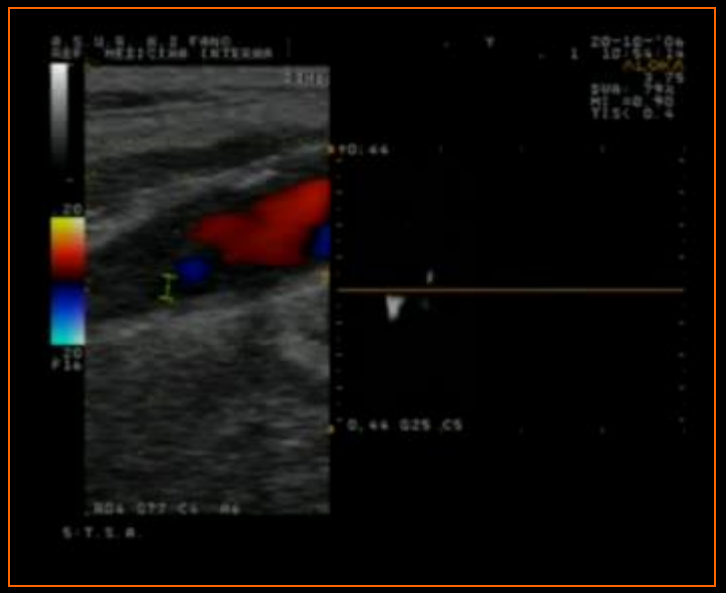
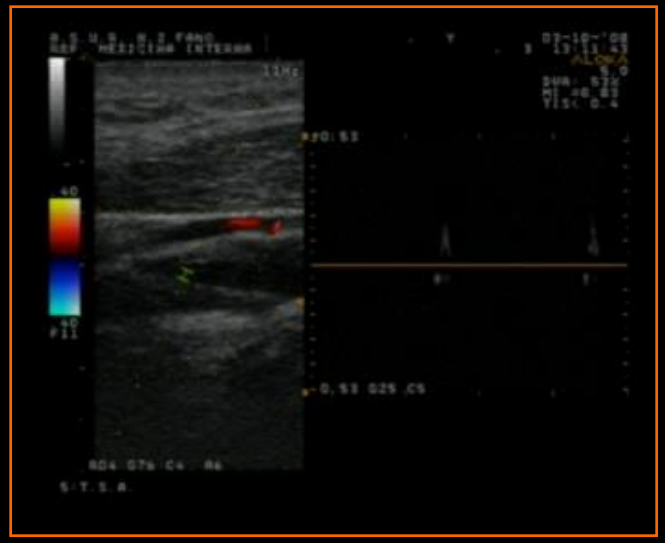


Trombosi carotide interna

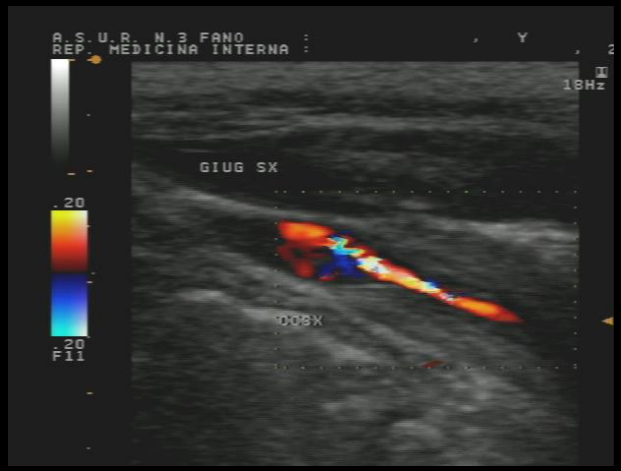




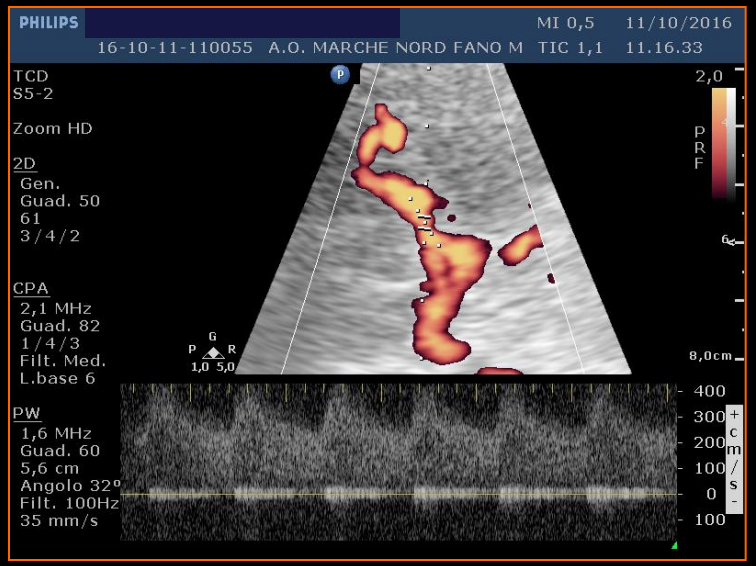
Dissecazione carotide interna

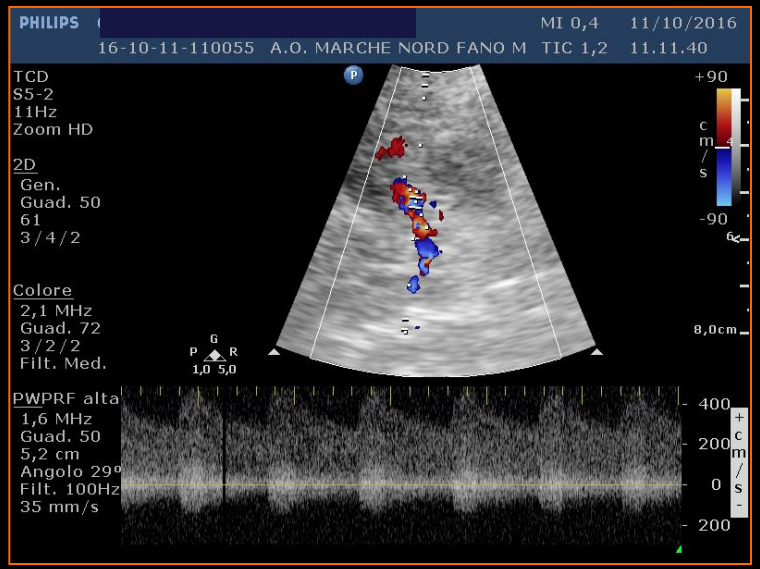


Arterite di Takayasu



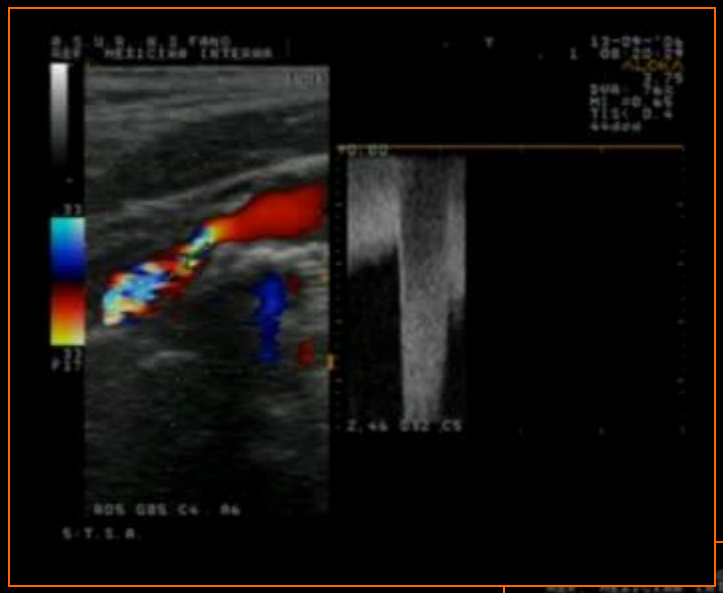
Stenosi cerebrale media

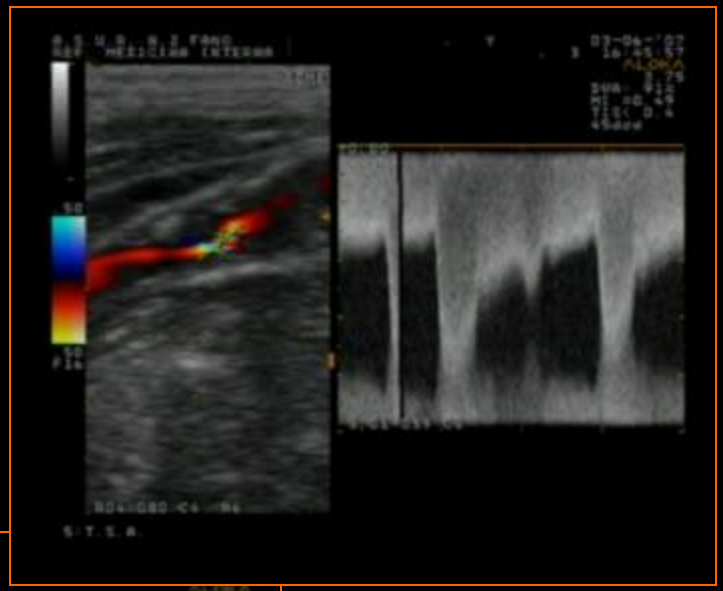


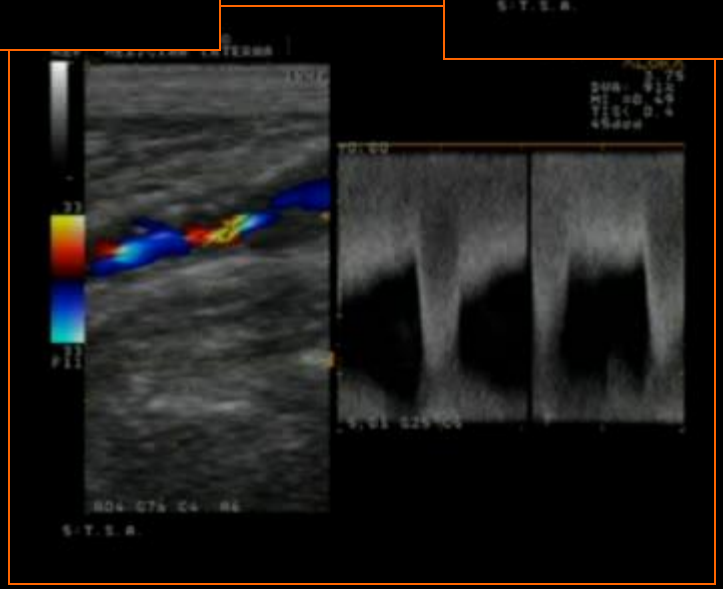


Trombosi cerebrale media

Stenosi carotide interna

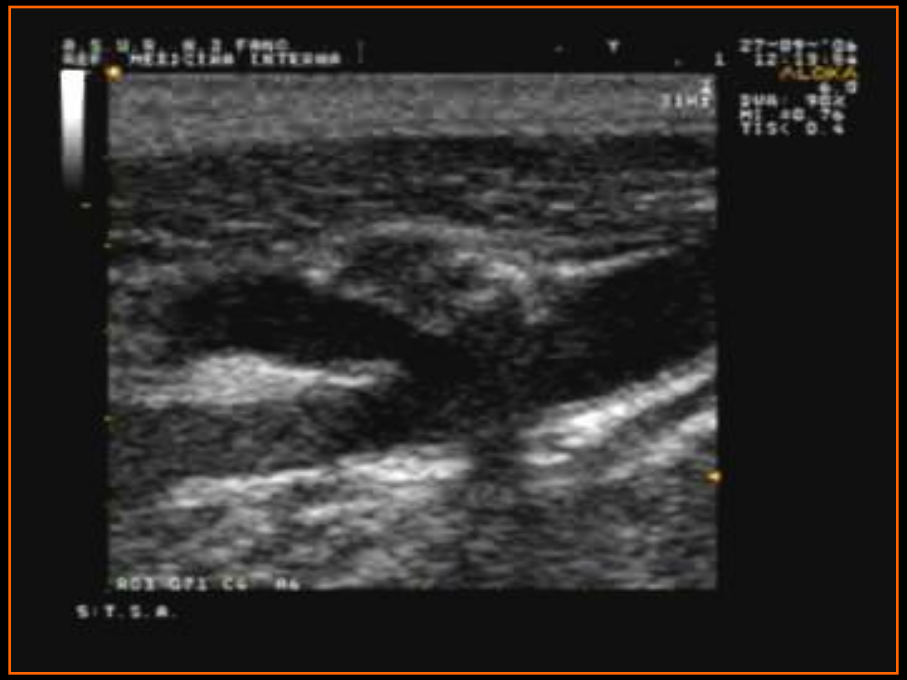






Eco-color-doppler
Tronchi Sopra-Aortici

Percentuale di stenosi



Caratteristiche morfo-strutturali della placca

STRANDNESS

UNIVERSITY OF WASHINGTON VELOCITY AND SPECTRAL WAVEFORM CRITERIA FOR CLASSIFICATION OF INTERNAL CAROTID ARTERY DISEASE

ARTERIOGRAPHIC DIAMETE RREDUCTION	PEAK SYSTOLIC VELOCITY	END-DIASTOLIC VELOCITY	SPECTRAL WAVEFORM CHARACTERISTICS
0% (normal)	<125 cm/s	—	Minimal or no spectral broadening; boundary layer separation present in the carotid bulb
1%-15%	<125 cm/s	—	Spectral broadening during deceleration phase of systole only
16%-49%	<125 cm/s	—	Spectral broadening throughout systole
50%-79%	≥125 cm/s	<140 cm/sec	Marked spectral broadening
80%-99%	≥125 cm/s	≥140 cm/sec	Marked spectral broadening
100% (occlusion)	—	—	No flow signal in the internal carotid artery; decreased diastolic flow in the ipsilateral common carotid artery

Diameter reduction is based on arteriographic methods that compared the residual internal carotid artery lumen diameter to the estimated diameter of the carotid bulb.
Velocity criteria are based on the angle-adjusted velocity using a Doppler angle of ≤60°.

Criteri velocitometrici per definire la stenosi carotidea

Autore	Stenosi	PSV IC	EDV IC	PSV IC/CC	SENS	SPEC
Carpentier	≥ 60 %	170			98	87
Moneta	≥ 60 %	260+	70		84	94
Carpentier	≥ 70 %	210			94	77
Moneta	≥ 70 %			4	91	87
Alexandrov	≥ 70 %	250			93	86

Criteri ultrasonografici per la valutazione del grado di stenosi
(Stanford Stroke Center)

Grado di stenosi	PSV	EDV	PSV ICA/CCA
< 50%	< 150 cm/s	< 50 cm/s	< 1,8
50% - 70%	150 – 250 cm/s	50 – 90 cm/s	1,8 – 2,8
70% - 90%	250 – 400 cm/s	90 – 150 cm/s	2,8 – 5
90% - 99%	> 400 cm/s	> 150 cm/s	> 5

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Index terms:
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Carotid arteries, stenosis or obstruction, 172.4311, 172.4312, 172.721
Carotid arteries, US, 172.12981, 172.12983, 172.12984
Special Reports

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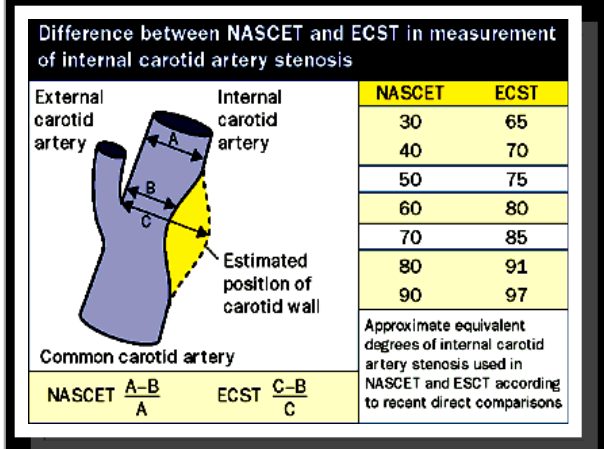
Carotid Artery Stenosis: Gray-Scale and Doppler US Diagnosis—Society of Radiologists in Ultrasound Consensus Conference[1]

The Society of Radiologists in Ultrasound convened a multidisciplinary panel of experts in the field of vascular ultrasonography (US) to come to a consensus regarding Doppler US for assistance in the diagnosis of carotid artery stenosis. The panel's consensus statement is believed to represent a reasonable position on the basis of analysis of available literature and panelists' experience. Key elements of the statement include the following: *(a)* All internal carotid artery (ICA) examinations should be performed with gray-scale, color Doppler, and spectral Doppler US. *(b)* The degree of stenosis determined at gray-scale and Doppler US should be stratified into the categories of normal (no stenosis), <50% stenosis, 50%–69% stenosis, ≥70% stenosis to near occlusion, near occlusion, and total occlusion. *(c)* ICA peak systolic velocity (PSV) and presence of plaque on gray-scale and/or color Doppler images are primarily used in diagnosis and grading of ICA stenosis; two additional parameters, ICA-to–common carotid artery PSV ratio and ICA end-diastolic velocity may also be used when clinical or technical factors raise concern that ICA PSV may not be representative of the extent of disease. *(d)* ICA should be diagnosed as (i) normal when ICA PSV is less than 125 cm/sec and no plaque or intimal thickening is visible; (ii) <50% stenosis when ICA PSV is less than 125 cm/sec and plaque or intimal thickening is visible; (iii) 50%–69% stenosis when ICA PSV is 125–230 cm/sec and plaque is visible; (iv) ≥70% stenosis to near occlusion when ICA PSV is greater than 230 cm/sec and visible plaque and lumen narrowing are seen; (v) near occlusion when there is a markedly narrowed lumen at color Doppler US; and (vi) total occlusion when there is no detectable patent lumen at gray-scale US and no flow at spectral, power, and color Doppler US. *(e)* The final report should discuss velocity measurements and gray-scale and color Doppler findings. Study limitations should be noted when they exist. The conclusion should state an estimated degree of ICA stenosis as reflected in the above categories. The panel also considered various technical aspects of carotid US and methods for quality assessment and identified several important unanswered questions meriting future research.

. Consensus Panel Gray-scale and Doppler US Criteria for diagnosis of ICA Stenosis

Degree of Stenosis (%)	Primary Parameters: ICA PSV (cm/sec)	Primary Parameters: Plaque Estimate (%)*	Additional Parameters: ICA/CCA PSV Ratio	Additional Parameters: 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

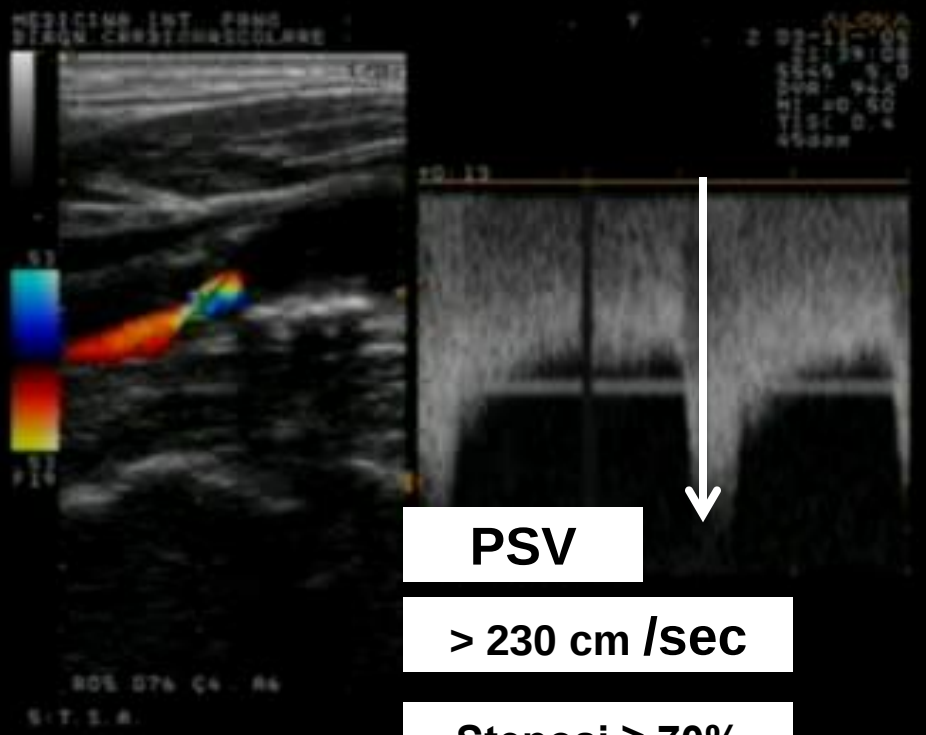


Plaque estimate %

(diameter reduction) with gray-scale and color DopplerUS.

Velocità di picco sistolico (ICA PSV cm/sec)

	Primary Parameters	
Degree of Stenosis (%)	ICA PSV (cm/sec)	Plaque Estimate (%)*
Normal	<125	None
<50	<125	<50
50–69	125–230	≥50
≥70 but less than near occlusion	>230	≥50
Near occlusion	High, low, or undetectable	Visible
Total occlusion	Undetectable	Visible, no detectable lumen

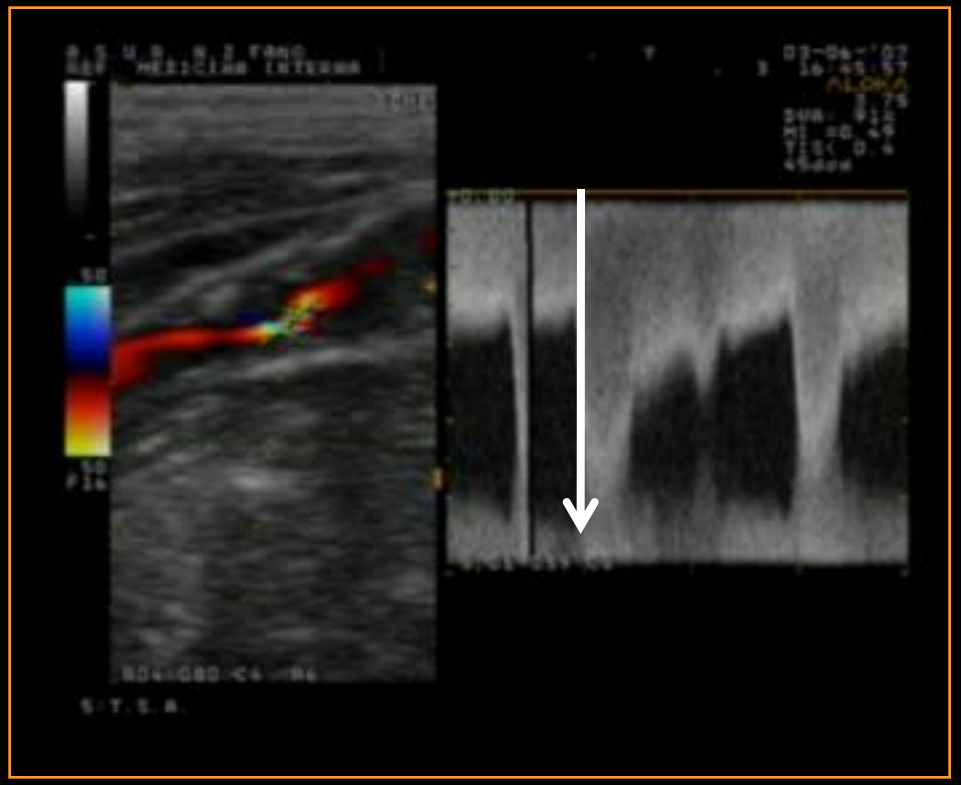


PSV

> 230 cm /sec

Stenosi ≥ 70%

Velocità di picco sistolico (ICA PSVcm/sec)



Velocità di picco sistolico (ICA PSV cm/sec)

Degree of Stenosis (%)	Primary Parameters: ICA PSV (cm/sec)	Primary Parameters: Plaque Estimate (%)*
Normal	<125	None
<50	<125	<50
50–69	125–230	≥50
≥70 but less than near occlusion	>230	≥50
Near occlusion	High, low, or undetectable	Visible
Total occlusion	Undetectable	Visible, no detectable lumen

ICA PSV
cm/sec

50–69 ~~125–230~~

140-230

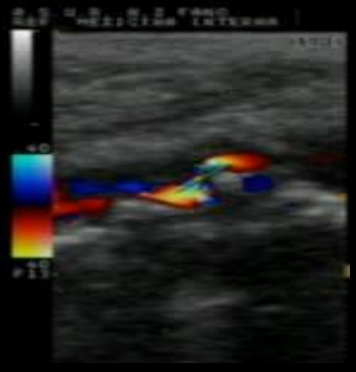
-the consensus criteria can be accurately used for diagnosing ≥ 70% stenosis; however, the accuracy can be improved for detecting 50% to 69 % stenosis if the ICA PSV is changed to 140 to < 230 cm/s, with a sensitivity of 94%, specificy of 92%, and overall accuracy of 92%.

"Critical appraisal of the carotid duplex consensus criteria in the diagnosis of carotid artery stenosis," AbuRahma, M. Srivastava, P. A. Stone et al., Journal of Vascular Surgery 2011

Stima placca
(riduzione percentuale di diametro)

Degree of Stenosis (%)	Primary Parameters: ICA PSV (cm/sec)	Primary Parameters: Plaque Estimate (%)*
Normal	<125	None
<50	<125	<50
50–69	125–230	≥50
≥70 but less than near occlusion	>230	≥50
Near occlusion	High, low, or undetectable	Visible
Total occlusion	Undetectable	Visible, no detectable lumen

Scala dei grigi

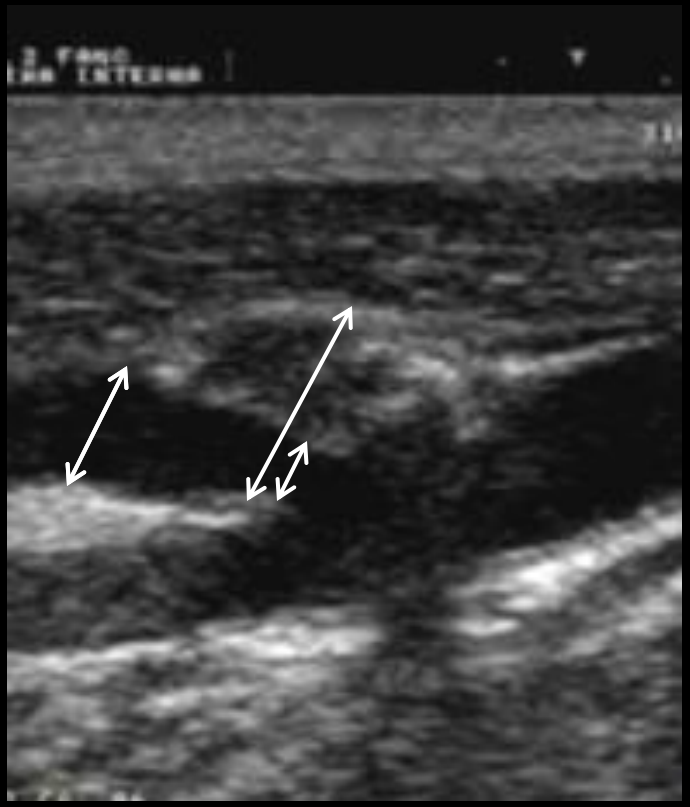


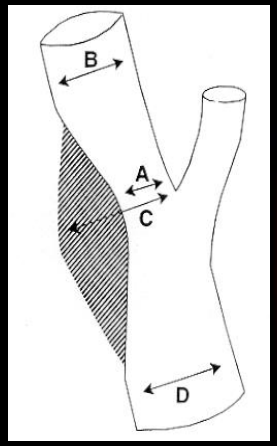
Color

Power

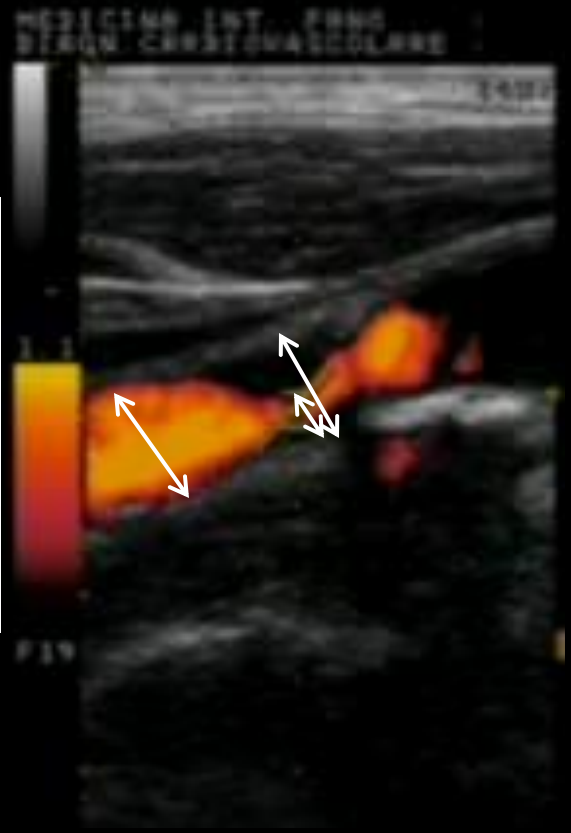
Riduzione % di diametro

Scala dei grigi

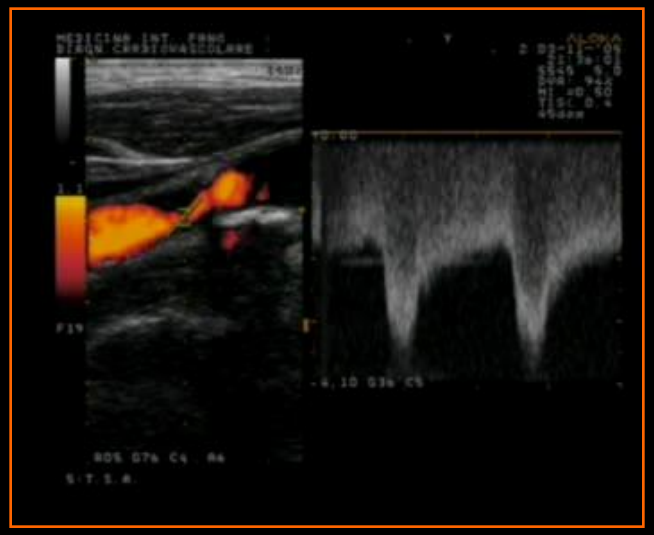




Power



Velocità di picco sistolico
(**ICA PSV cm/sec**)



Stima placca (%)
(riduzione percentuale di diametro)

Pitfalls

Presenza di stenosi tandem

Presenza di stenosi di alto grado controlaterale o occlusioni

Attivazione dei circoli collaterali di compenso

Completezza del circolo di Willis

Flusso vertebrale

Stato cardiaco iperdinamico

Bassa gettata cardiaca

Consensus Panel
Gray-scale and Doppler US Criteria for diagnosis of ICA Stenosis

Degree of Stenosis (%)	Primary Parameters: ICA PSV (cm/sec)	Primary Parameters: Plaque Estimate (%)*	Additional Parameters: ICA/CCA PSV Ratio	Additional Parameters: 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

Grading Carotid Stenosis Using Ultrasonic Methods

Gerhard-Michael von Reutern, MD, PhD; Michael-Wolfgang Goertler, MD, PhD; Natan M. Bornstein, MD; Massimo Del Sette, MD; David H. Evans, PhD, DSc; Andreas Hetzel, MD, PhD; Manfred Kaps, MD, PhD; Fabienne Perren, MD, PhD; Alexander Razumovky, PhD; Toshiyuki Shiogai, MD, PhD; Ekaterina Titianova, MD, PhD, DSc; Pavel Traubner, MD, PhD; Narayanaswamy Venketasubramanian, MD; Lawrence K.S. Wong, MD; Masahiro Yasaka, MD, PhD; on behalf of the Neurosonology Research Group of the World Federation of Neurology

Abstract—The controversy as to whether Doppler ultrasonic methods should play a role in clinical decision-making in the prevention of stroke is attributable to reported disagreement between angiographic and ultrasonic results and the lack of internationally accepted ultrasound criteria for describing the degree of stenosis. Foremost among the explanations for both is the broad scatter of peak systolic velocities in the stenosis, the criterion that has so far received most attention. Grading based on a set of main and additional criteria can overcome diagnostic errors. Morphological measurements (B-mode images and color flow imaging) are the main criteria for low and moderate degrees of stenosis. Increased velocities in the stenosis indicate narrowing, but the appearance of collateral flow and decreased poststenotic flow velocity prove a high degree stenosis (≥70%), additionally allowing the estimation of the hemodynamic effect in the category of high-degree stenosis. Additional criteria refer to the effect of a stenosis on prestenotic flow (common carotid artery), the extent of poststenotic flow disturbances, and derived velocity criteria (diastolic peak velocity and the carotid ratio). This multiparametric approach is intended to increase the reliability and the standard of reporting of ultrasonic results for arteriosclerotic disease of the carotid artery. (***Stroke*****. 2012;43:916-921.)**

Key Words: carotid stenosis ■ degree of stenosis ■ duplex sonography ■ peak systolic velocity ■ transcranial sonography ■ ultrasound diagnosis

Main and Additional Criteria combined for Grading Internal Carotid Stenosis

Table. Combined Criteria for Grading Internal Carotid Stenosis

	Grading of Internal Carotid Stenosis						
Degree of Stenosis as Defined							
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
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 ratio ICA/CCA	<2	≥2	≥2	>4	>4	Variable	NA
(severity and length)							
8. End-diastolic flow velocity in the stenosis (cm/s)			<100	>100		Variable	NA
9. Carotid ratio ICA/CCA	<2	≥2	≥2	>4	>4	Variable	NA

Grading Craotid Stenosis Using Ultrasonic Methods Stroke 2012

Eco-color-doppler
Tronchi Sopra-Aortici

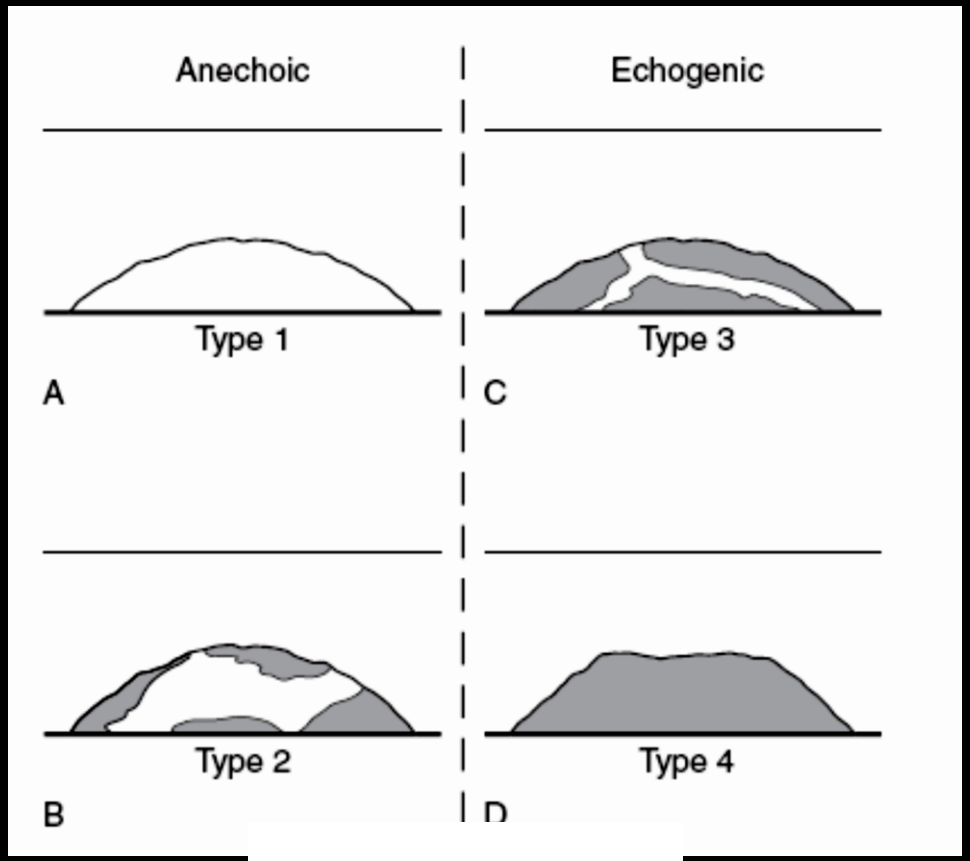
Percentuale di stenosi

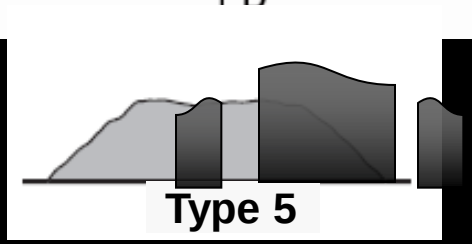
Caratteristiche morfo-strutturali della placca

La “placca “carotidea: caratteristiche ecografiche e rischio di ictus

La placca “vulnerabile”

CLASSIFICAZIONE
di Gray-Weale





TIPO 1: Uniformemente ipo-anecogena: meno del 15% dell'area è occupato da aree iperecogene.

TIPO 2: Prevalentemente ipo-anecogena: aree iper-ecogene dal 15 al 50%

TIPO 3: Prevalentemente ecogena: le aree iper-ecogene dal 50-85%

TIPO 4: Uniformemente ecogena: aree iperecogene più dell'85%

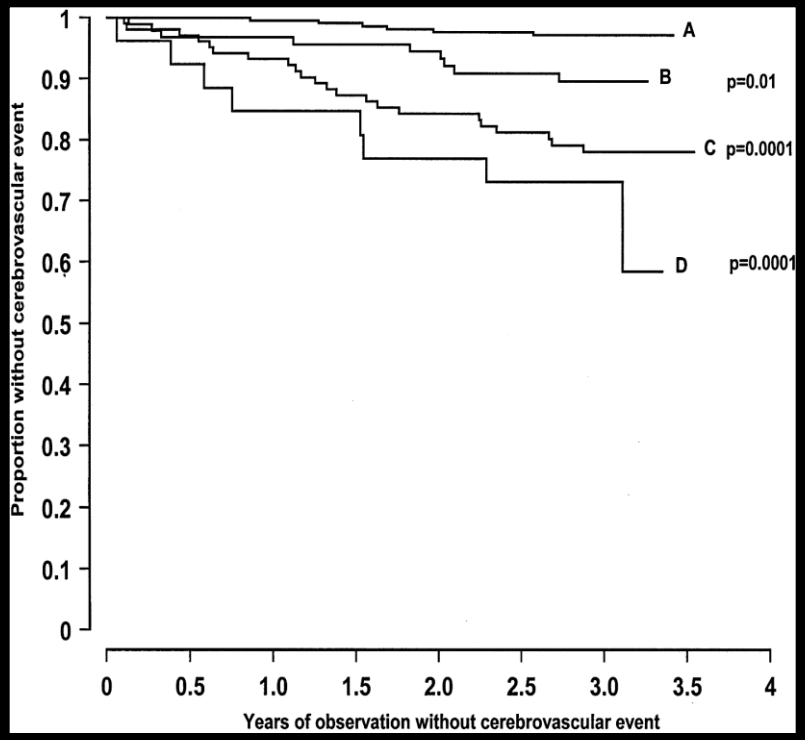
TIPO 5: Superficie calcifica > 15%, con "cono d'ombra"che impedisce di visualizzare la placca

J Cardiovasc Surg 1988; Nicolaides, International Angiol 1995, J Ultrasound Med 2000

La placca carotidea "vulnerabile"

Ecogenicità di placca ed eventi CV

The Tromso Study



Gray Weale	eventi CV a 3 anni
Tipo I: echolucent	29.6%
Tipo II: predominantly echolucent	21.4%
Tipo III: predominantly echogenic	9.7%
Tipo IV: echogenic	9.5%

EB Mathiesen, Circ 2001

Plaque Echolucency and Stroke Risk in Asymptomatic Carotid Stenosis

A Systematic Review and Meta-Analysis

Ajay Gupta, MD; Kartik Kesavabhotla, MD; Hediyeh Baradaran, MD; Hooman Kamel, MD; Ankur Pandya, PhD; Ashley E. Giambrone, PhD; Drew Wright, MS, MLS; Kevin J. Pain, BA; Edward E. Mtui, MD; Jasjit S. Suri, MS, MBA, PhD; Pina C. Sanelli, MD, MPH; Alvin I. Mushlin, MD, ScM

Background and Purpose—Ultrasonographic plaque echolucency has been studied as a stroke risk marker in carotid atherosclerotic disease. We performed a systematic review and meta-analysis to summarize the association between ultrasound-determined carotid plaque echolucency and future ipsilateral stroke risk.

Methods—We searched the medical literature for studies evaluating the association between carotid plaque echolucency and future stroke in asymptomatic patients. We included prospective observational studies with stroke outcome ascertainment after baseline carotid plaque echolucency assessment. We performed a meta-analysis and assessed study heterogeneity and publication bias. We also performed subgroup analyses limited to patients with stenosis ≥50%, studies in which plaque echolucency was determined via subjective visual interpretation, studies with a relatively lower risk of bias, and studies published after the year 2000.

Results—We analyzed data from 7 studies on 7557 subjects with a mean follow-up of 37.2 months. We found a significant positive relationship between predominantly echolucent (compared with predominantly echogenic) plaques and the risk of future ipsilateral stroke across all stenosis severities (0% to 99%; relative risk, 2.31; 95% confidence interval, 1.58–3.39; $P<0.001$) and in subjects with ≥50% stenosis (relative risk, 2.61; 95% confidence interval, 1.47–4.63; $P=0.001$). A statistically significant increased relative risk for future stroke was preserved in all additional subgroup analyses. No statistically significant heterogeneity or publication bias was present in any of the meta-analyses.

CONCLUSIONS:

The presence of ultrasound-determined carotid plaque echolucency provides predictive information in asymptomatic carotid artery stenosis beyond luminal stenosis. However, the magnitude of the increased risk is not sufficient on its own to identify patients likely to benefit from surgical revascularization.

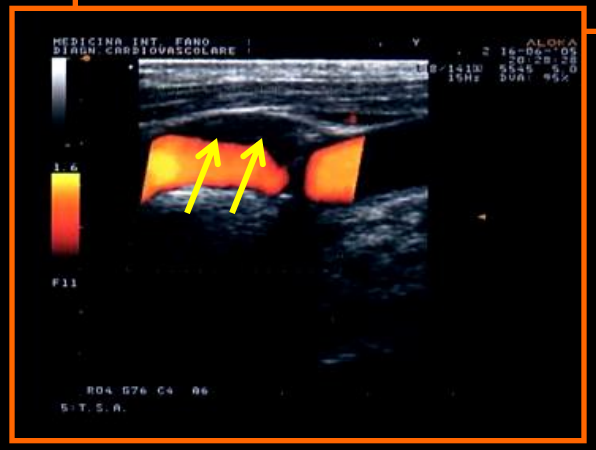
Stroke, 2015

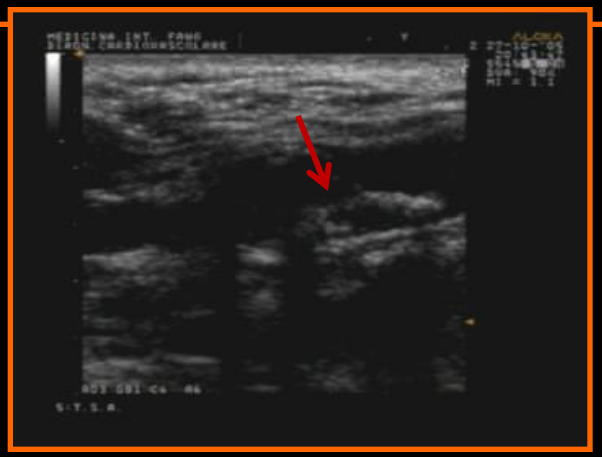
La placca "vulnerabile"

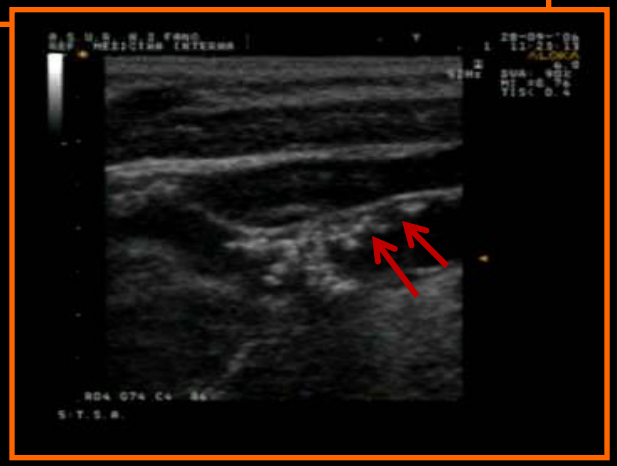
Placche ana-ipoecogene (core lipidico-necrotico, emorragia intraplacca ►Tipo1 e Tipo2 GW)

Cappuccio fibroso sottile

Placca a superficie irregolare-ulcerata (Irregolare: 0.4-2 mm Ulcerata: >2 mm)







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Stroke Prevention And Educational Awareness Diffusion

Raccomandazione Forte a favore

Lo studio ecocolordoppler dei tronchi sovra-aortici è raccomandato nei soggetti con TIA o ictus ischemico recente per un migliore inquadramento eziopatogenetico.

Raccomandazione Forte a favore

Lo studio ecocolordoppler dei tronchi sovra-aortici è raccomandato nella valutazione della stenosi carotidea ai fini della scelta terapeutica in senso chirurgico, quale indagine conclusiva e quindi sostitutiva dell'angiografia, dopo averne verificato l'accuratezza, eventualmente completata con i dati di altre tecniche non invasive di neuroimmagine (angio-RM; angio-TC).

% stenosi carotidea e chirurgia carotidea

PAZIENTE	% STENOSI NASCET				
SINTOMATICO	**≤50%**	**50-69%**	**≥70%**	**Near occlusion**	**Occlusion**
ASINTOMATICO			**≥70%**		

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Stroke Prevention And Educational Awareness Diffusion

Raccomandazione Forte a favore

L'endoarteriectomia carotidea è raccomandata nella stenosi sintomatica compresa fra il 50% ed il 69% (equivalente a metodo NASCET) nel paziente con almeno una delle seguenti condizioni se il rischio perioperatorio (fino a 1 mese dall'intervento) di morte e ogni tipo di ictus e inferiore a 6%:

- ischemia recente (< 2 mesi dal sintomo)
- sintomo cerebrale e non oculare
- placca ulcerata – vulnerabile
- sesso maschile
- assenza di diabete

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Stroke Prevention And Educational Awareness Diffusion

Raccomandazione Debole a favore

L'intervento di endoarteriectomia, in caso di stenosi carotidea asintomatica uguale o maggiore al 70% (equivalente a metodo NASCET), è indicato solo se l'aspettativa di vita del paziente e di almeno 3 anni e se il rischio perioperatorio (fino a 1 mese dall'intervento) di complicanze (morte e ogni tipo di ictus) e inferiore a 3%, con vantaggio dell'intervento tanto maggiore quanto minore e tale rischio.

Le attuali evidenze sul beneficio dell'endoarteriectomia nella stenosi carotidea asintomatica sottolineano l'importanza di valutare il vantaggio della terapia chirurgica nei confronti della miglior terapia medica. Il rischio di ictus nei pazienti trattati con la miglior terapia medica risulta oggi mediamente inferiore all'1% per anno (cioè inferiore al rischio della procedura chirurgica nell'ACAS e nell'ACST), pertanto l'intervento non può essere raccomandato di routine, ma indicato solo in pazienti selezionati, e in centri specialistici con documentato rischio perioperatorio di ictus/morte più basso possibile, inferiore a 2%e ancora meglio se inferiore a 1%.
Alcuni studi indicano sottogruppi di pazienti a più netto beneficio dall'intervento in quanto a maggior rischio di ictus se non operati, quali pazienti con pregressi infarti alla TC encefalo, più alto grado di stenosi carotidea o più rapida progressione di stenosi,presenza di occlusione carotidea controlaterale, morfologia di placca ulcerata o irregolare agli ultrasuoni o all'RM e/o presenza di segnali microembolici omolaterali all'ecodoppler transcranico. Altri studi indicano viceversa sottogruppi di pazienti a piu scarso o senza beneficio dall'intervento in quanto a maggior rischio di complicanze se operati. Sono auspicabili quindi altre revisioni sistematiche e ulteriori studi che stratifichino i vari fattori di rischio medico e chirurgico, onde specificare meglio le indicazioni o controindicazioni all'intervento

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Stroke Prevention And Educational Awareness Diffusion

Raccomandazione Debole a favore

In caso di stenosi carotidea asintomatica l'endoarteriectomia, comportando un beneficio modesto rispetto alla miglior terapia medica, è indicata nel paziente che e' considerato "a rischio" se trattato solo con terapia medica e che presenta quindi almeno una di queste condizioni: pregresso infarto anche silente alla TC/RM encefalo, placca vulnerabile o ulcerata o a rapida crescita, stenosi pre-occlusiva, stenosi tra 70-80% (equivalente a metodo NASCET) con occlusione della carotide controlaterale o con presenza all'ecodoppler transcranico di segnali microembolici omolaterali. E' invece indicata la sola miglior terapia medica nel paziente con aspettativa di vita inferiore a quella presunta per ottenere il beneficio dall'endoarteriectomia, quale il paziente ultraottantenne o con diabete insulino-dipendente o cardiopatia grave o broncopatia grave o insufficienza renale cronica in trattamento dialitico.

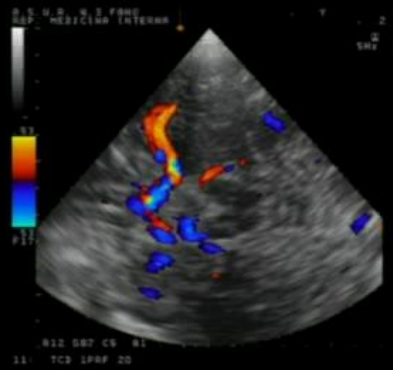
Eco-color-doppler Tronchi Sopra-Aortici /TCCD

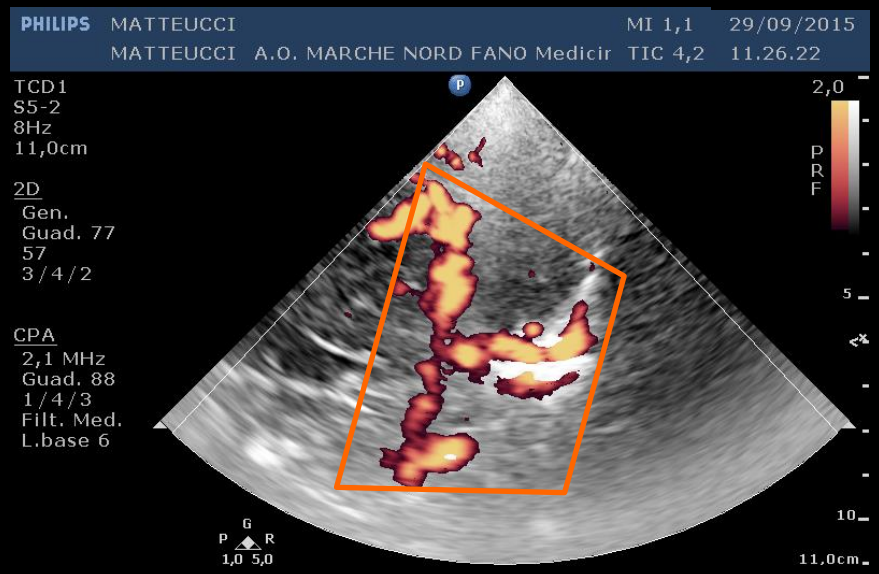
- Caratteristiche ecogeniche della placca
- Presenza di stenosi di alto grado controlaterale o occlusioni
- Registrazione di segnali microembolici
- Presenza di stenosi intracraniche
- Individuazione circoli collaterali attivati

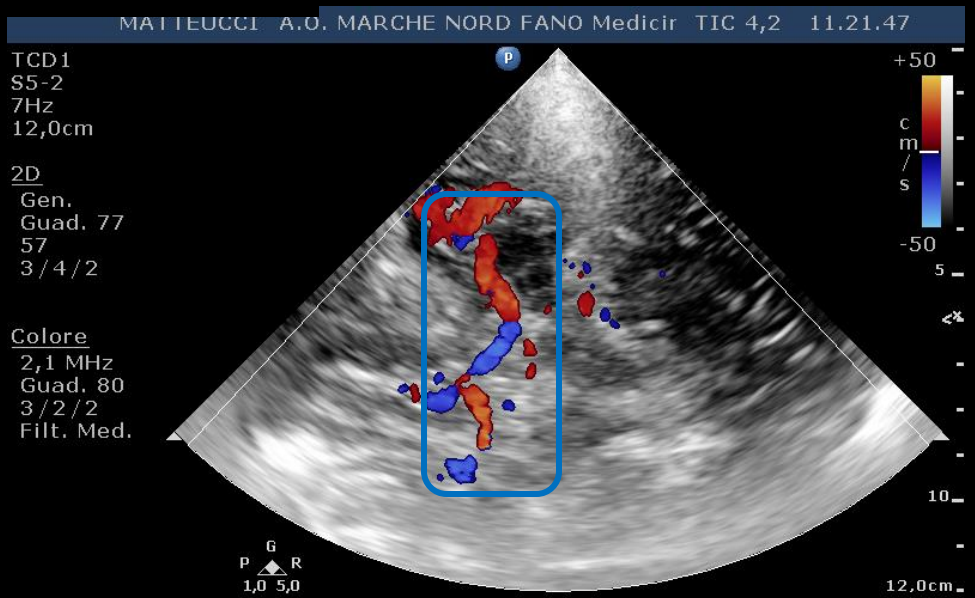
La mente umana come il paracadute: funziona al meglio quando è aperta

(Charlie Chan)

Eco-color-doppler Transcranico (TCCD)



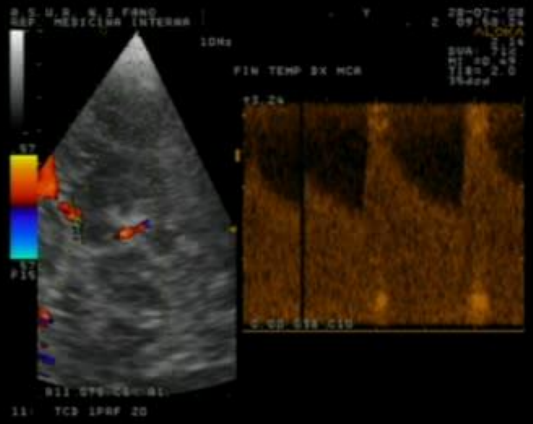


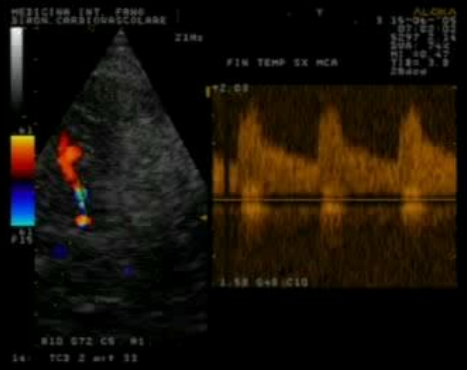


Eco-color-doppler Transcranico e ictus ischemico acuto

Individuare la presenza di stenosi intracraniche

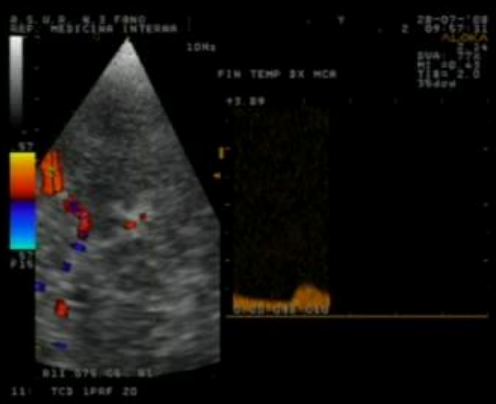
Stenosi della a. cerebrale media

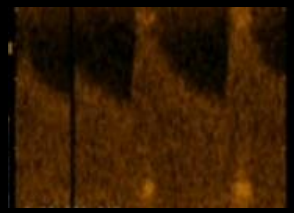




STENOSI M1 MCA

MCA: max. flow vel. = 3,24 m/sec.

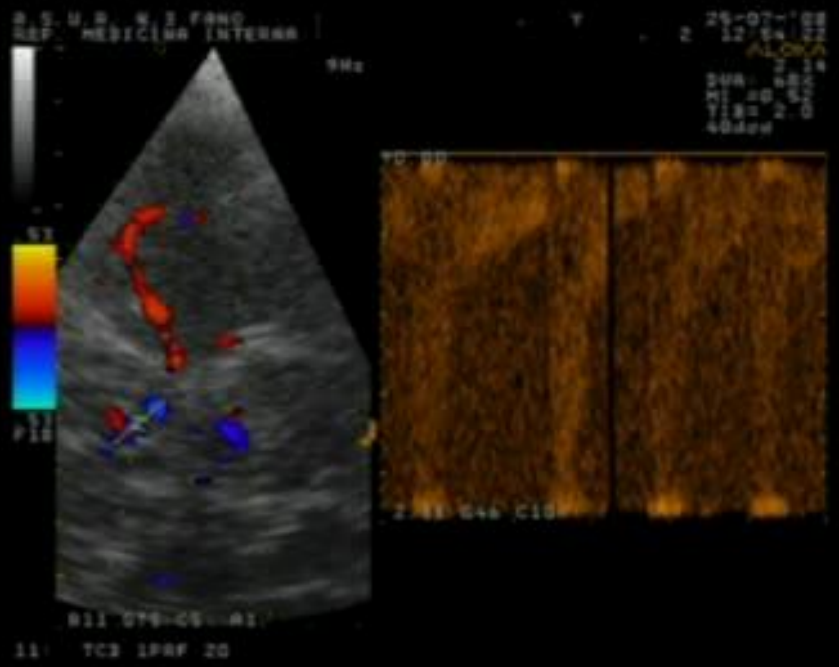


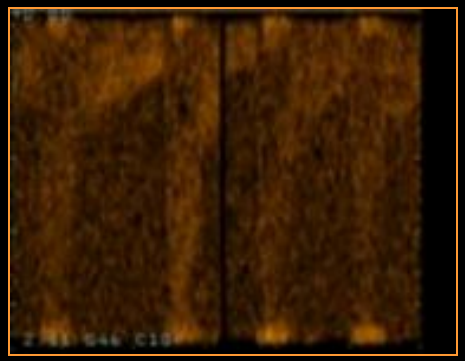


Eco-color-doppler Transcranico e ictus ischemico acuto

Individuare la presenza di stenosi intracraniche

Stenosi della a. cerebrale anteriore





STENOSI ACA A1

ACA: max. flow vel. = 2,31 m/sec

STATO VASCOLARE INTRACRANICO

Criteri emodinamici di stenosi intracranica

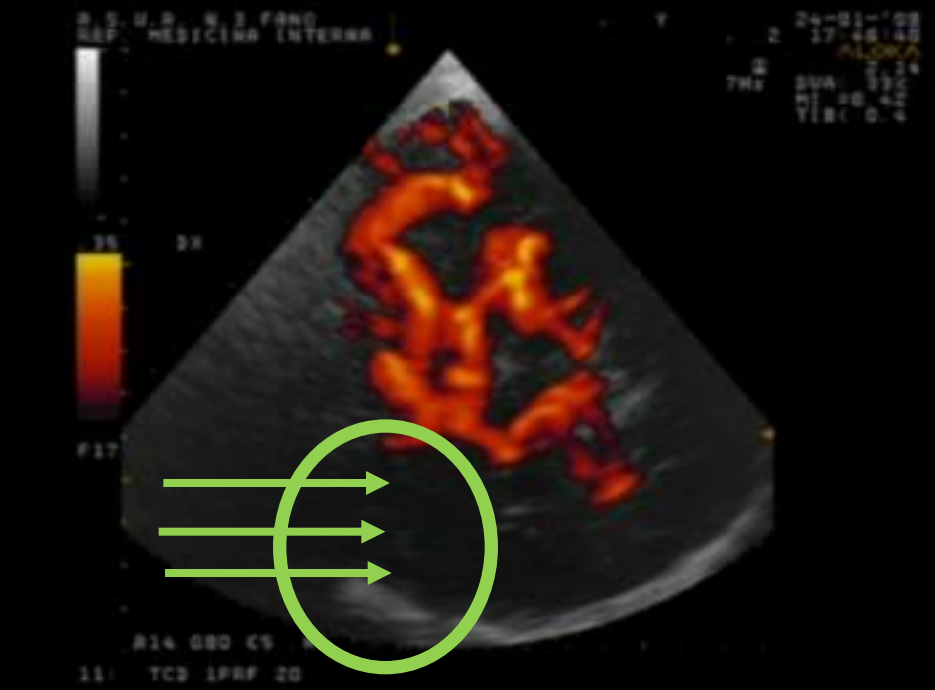
Baumgartner R.W. (Stroke ’99):

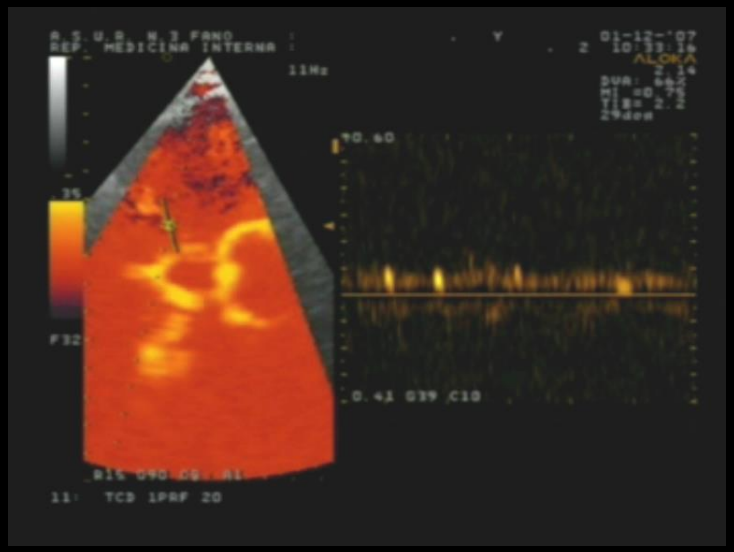
≥50%	≤50%	
>=220 cm.sec	>=155 cm.sec	(arteria cerebrale media)
>=155 cm.sec	>=120 cm.sec	(arteria cerebrale anteriore)
>=145 cm.sec	>=100 cm.sec	(arteria cerebrale posteriore)
>=120 cm.sec	>=90 cm.sec	(arteria vertebrale)
>=140 cm.sec	>=100 cm.sec	(arteria basilare)

Eco-color-doppler transcranico (TCCD) e ictus ischemico acuto

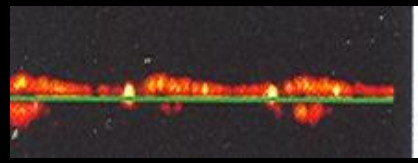
Identificare la sede dell' occlusione

Occlusione della cerebrale media





TIBI flow grade



1 **Minimal flow signal**
Absend end-diastolic flow

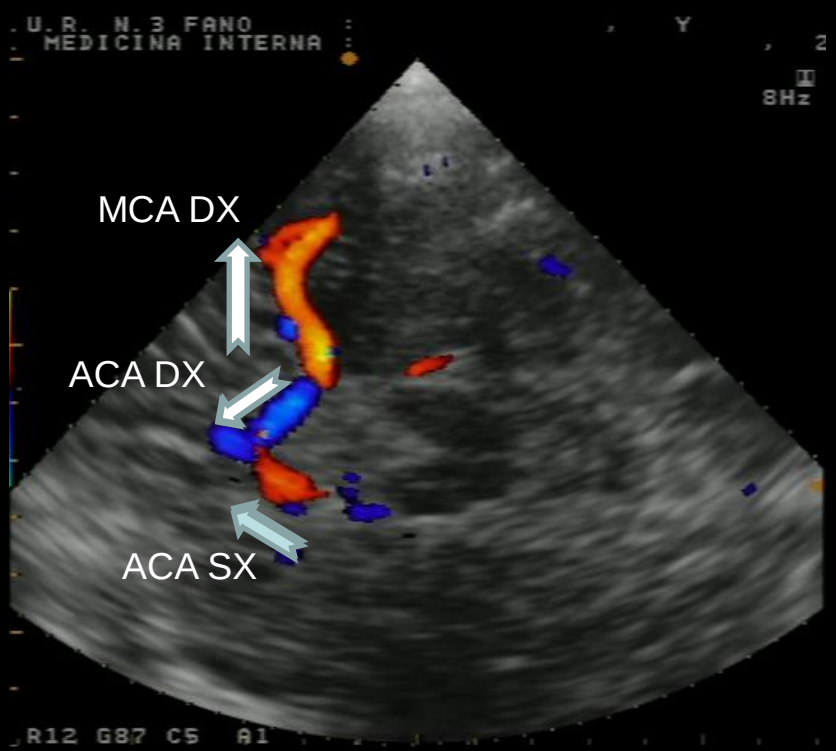
Criteri di occlusione vasale

Assenza del segnale colore e
perdita dello spettro doppler
nel segmento occluso
mentre gli altri vasi del circolo di Willis
possono essere chiaramente individuati

Flusso invertito sulla ACA A1

(a. comunicante anteriore attivata)

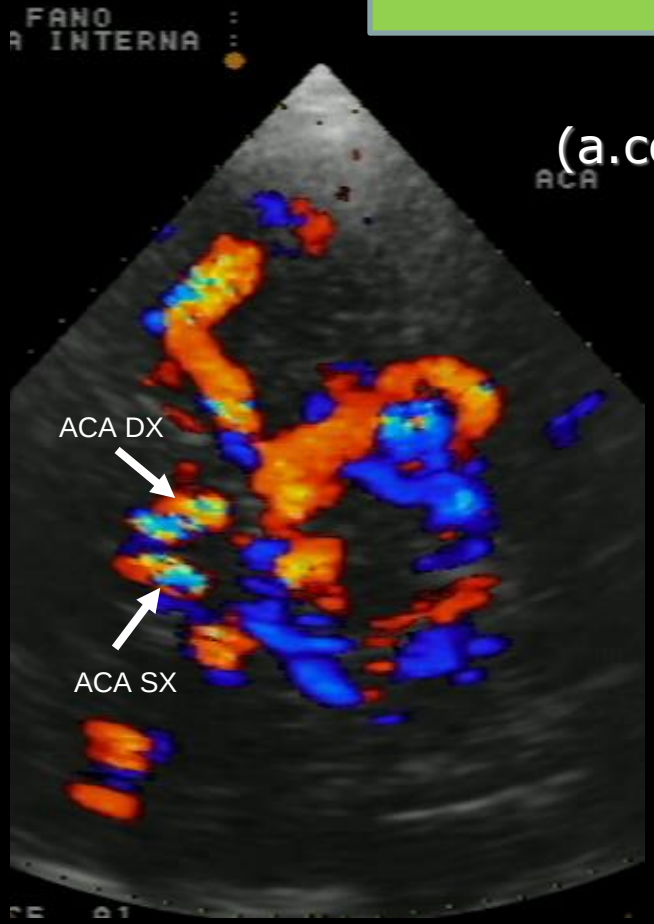
Studiare l'attivazione dei circoli collaterali di compenso

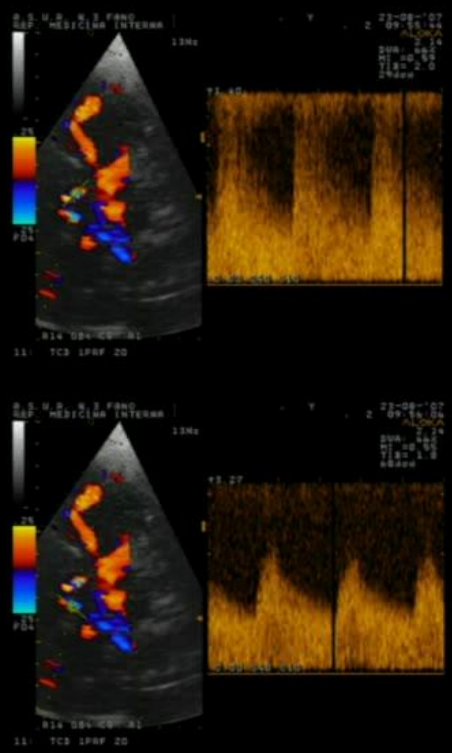


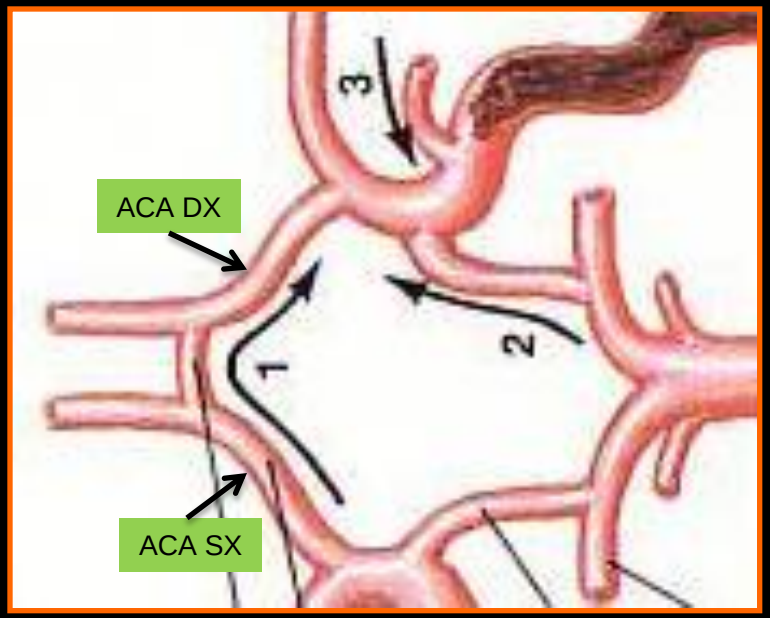
Eco-color-doppler transcranico (TCCD) e ictus ischemico acuto

Studiare l'attivazione dei circoli collaterali di compenso

Flusso invertito ACA A1
(a.comunicante anteriore attivata)

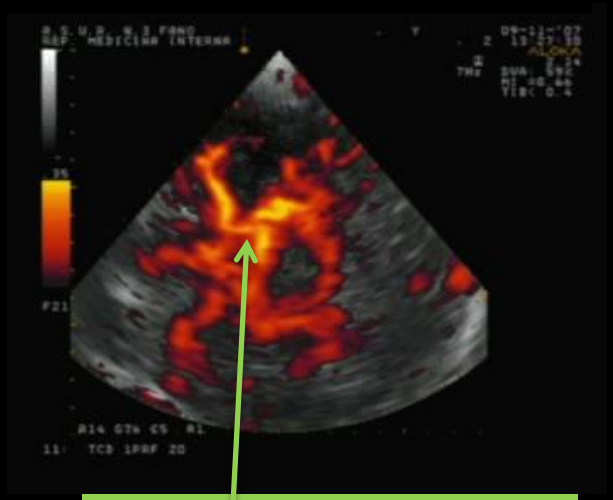






Eco-color-doppler transcranico (TCCD) e ictus ischemico acuto

Studiare l'attivazione dei circoli collaterali di compenso



A.Comunicante posteriore

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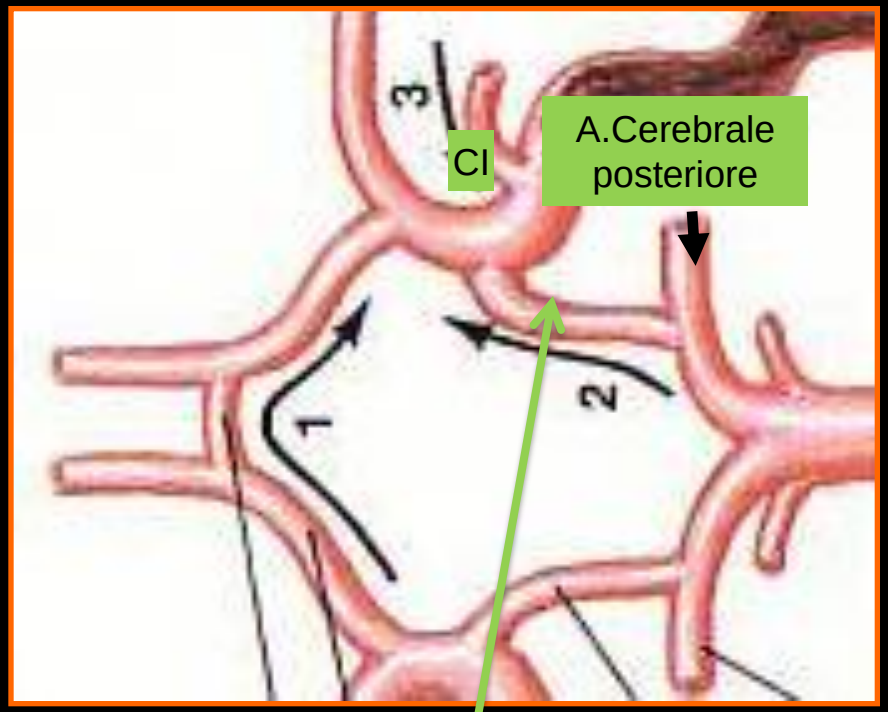
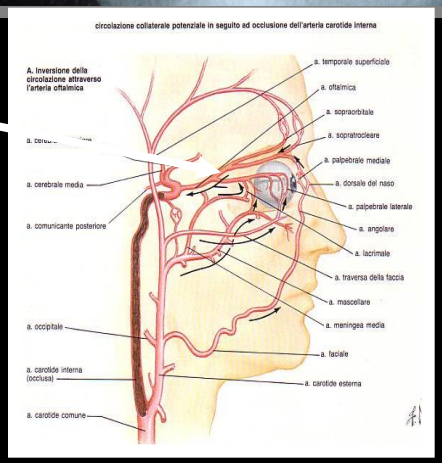


A.Comunicante posteriore

Eco-color-doppler transcranico (TCCD) e ictus ischemico acuto

Studiare l'attivazione dei circoli collaterali di compenso

- Inversione di flusso sulla a. oftalmica



Oftalmica invertitata

Oftalmica **normodiretta**

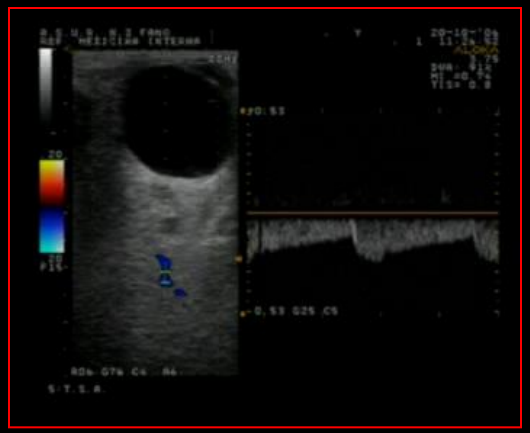
TSA +TCCD
nell'ictus cerebrale ischemico acuto

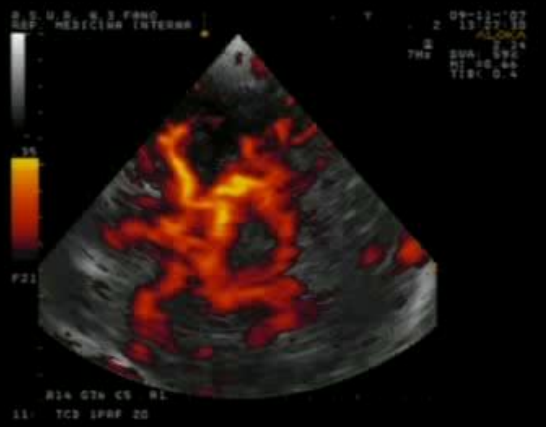
"If you don't know where you're going every path will take you there"

Antico proverbio pellerossa

- Diagnosi
- Prognosi
- Trattamento

TSA + TCCD
nell'ischemia cerebrale transitoria





Grazie per l’attenzione

Grading Carotid Stenosis Using Ultrasonic Methods

Gerhard-Michael von Reutern, MD, PhD; Michael-Wolfgang Goertler, MD, PhD; Natan M. Bornstein, MD; Massimo Del Sette, MD; David H. Evans, PhD, DSc; Andreas Hetzel, MD, PhD; Manfred Kaps, MD, PhD; Fabienne Perren, MD, PhD; Alexander Razumovky, PhD; Toshiyuki Shiogai, MD, PhD; Ekaterina Titianova, MD, PhD, DSc; Pavel Traubner, MD, PhD; Narayanaswamy Venketasubramanian, MD; Lawrence K.S. Wong, MD; Masahiro Yasaka, MD, PhD; on behalf of the Neurosonology Research Group of the World Federation of Neurology

Abstract—The controversy as to whether Doppler ultrasonic methods should play a role in clinical decision-making in the prevention of stroke is attributable to reported disagreement between angiographic and ultrasonic results and the lack of internationally accepted ultrasound criteria for describing the degree of stenosis. Foremost among the explanations for both is the broad scatter of peak systolic velocities in the stenosis, the criterion that has so far received most attention. Grading based on a set of main and additional criteria can overcome diagnostic errors. Morphological measurements (B-mode images and color flow imaging) are the main criteria for low and moderate degrees of stenosis. Increased velocities in the stenosis indicate narrowing, but the appearance of collateral flow and decreased poststenotic flow velocity prove a high degree stenosis (≥70%), additionally allowing the estimation of the hemodynamic effect in the category of high-degree stenosis. Additional criteria refer to the effect of a stenosis on prestenotic flow (common carotid artery), the extent of poststenotic flow disturbances, and derived velocity criteria (diastolic peak velocity and the carotid ratio). This multiparametric approach is intended to increase the reliability and the standard of reporting of ultrasonic results for arteriosclerotic disease of the carotid artery. (***Stroke*****. 2012;43:916-921.)**

Key Words: carotid stenosis ■ degree of stenosis ■ duplex sonography ■ peak systolic velocity ■ transcranial sonography ■ ultrasound diagnosis

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Editorial

Endarterectomy, Stenting, or Neither for Asymptomatic Carotid-Artery Stenosis

J. David Spence, M.D., and A. Ross Naylor, M.D.
N Engl J Med 2016; 374:1087-1088

Plaque Echolucency and Stroke Risk in Asymptomatic Carotid Stenosis

A Systematic Review and Meta-Analysis

Ajay Gupta, MD; Kartik Kesavabhotla, MD; Hediyeh Baradaran, MD; Hooman Kamel, MD; Ankur Pandya, PhD; Ashley E. Giambrone, PhD; Drew Wright, MS, MLS; Kevin J. Pain, BA; Edward E. Mtui, MD; Jasjit S. Suri, MS, MBA, PhD; Pina C. Sanelli, MD, MPH; Alvin I. Mushlin, MD, ScM

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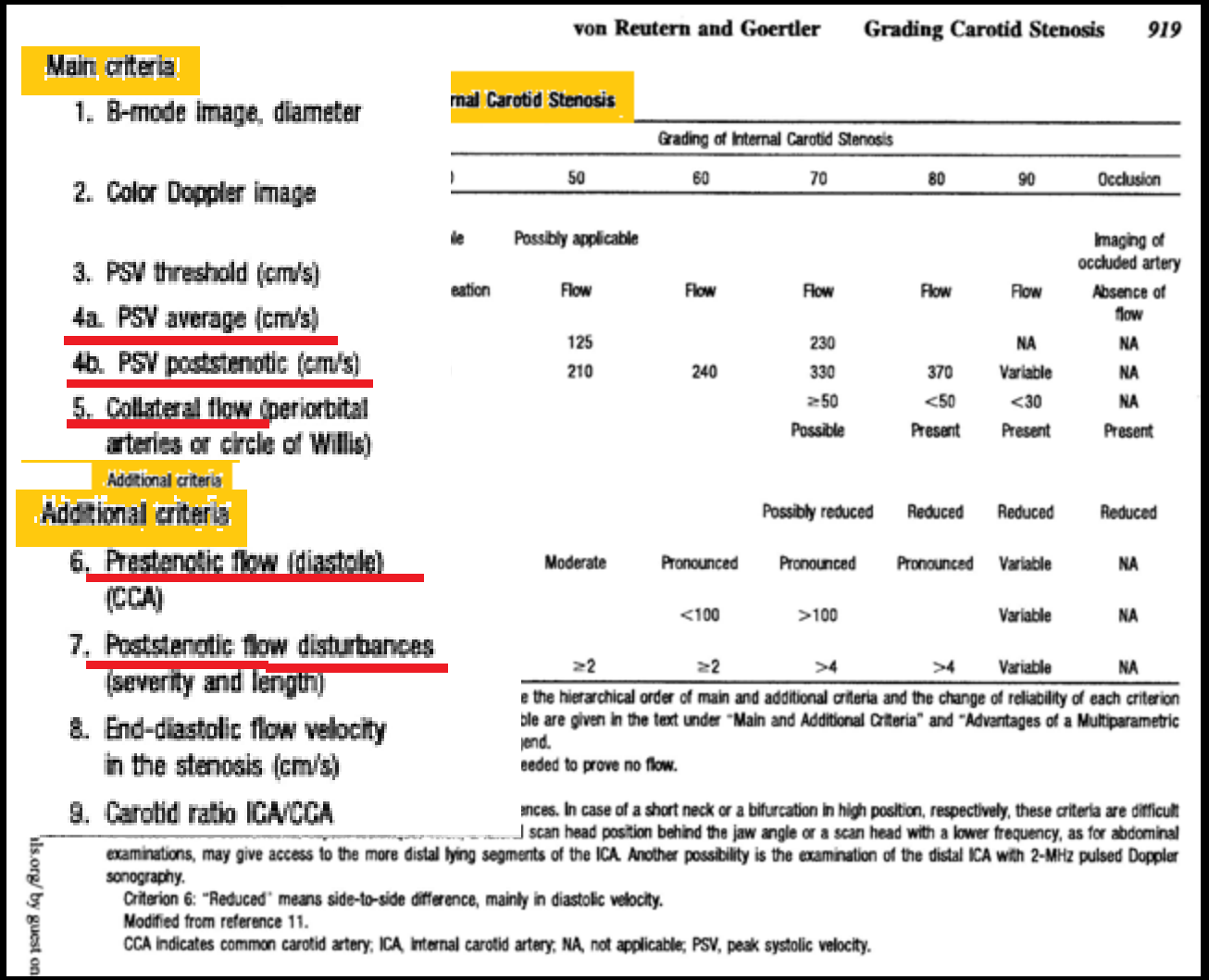
Methods—We searched the medical literature for studies evaluating the association between carotid plaque echolucency and future stroke in asymptomatic patients. We included prospective observational studies with stroke outcome ascertainment after baseline carotid plaque echolucency assessment. We performed a meta-analysis and assessed study heterogeneity and publication bias. We also performed subgroup analyses limited to patients with stenosis ≥50%, studies in which plaque echolucency was determined via subjective visual interpretation, studies with a relatively lower risk of bias, and studies published after the year 2000.

Results—We analyzed data from 7 studies on 7557 subjects with a mean follow-up of 37.2 months. We found a significant positive relationship between predominantly echolucent (compared with predominantly echogenic) plaques and the risk of future ipsilateral stroke across all stenosis severities (0% to 99%; relative risk, 2.31; 95% confidence interval, 1.58–3.39; $P<0.001$) and in subjects with ≥50% stenosis (relative risk, 2.61; 95% confidence interval, 1.47–4.63; $P=0.001$). A statistically significant increased relative risk for future stroke was preserved in all additional subgroup analyses. No statistically significant heterogeneity or publication bias was present in any of the meta-analyses.

The presence of ultrasound-determined carotid plaque echolucency provides predictive information in asymptomatic carotid artery stenosis beyond luminal stenosis. However, the magnitude of the increased risk is not sufficient on its own to identify patients likely to benefit from surgical revascularization.

Stroke.**2015**

Main and Additional Criteria combined for Grading Internal Carotid Stenosis



Main criteria

1. B-mode image, diameter
2. Color Doppler image
3. PSV threshold (cm/s)
4. a. PSV average (cm/s)
   b. PSV poststenotic (cm/s)
5. Collateral flow (periorbital arteries or circle of Willis)

Additional criteria

6. Prestenotic flow (diastole) (CCA)
7. Poststenotic flow disturbances (severity and length)
8. End-diastolic flow velocity in the stenosis (cm/s)
9. Carotid ratio ICA/CCA

rnal Carotid Stenosis

	Grading of Internal Carotid Stenosis					
	50	60	70	80	90	Occlusion
le	Possibly applicable					Imaging of occluded artery
eation	Flow	Flow	Flow	Flow	Flow	Absence of flow
	125		230		NA	NA
	210	240	330	370	Variable	NA
			≥50	<50	<30	NA
			Possible	Present	Present	Present
			Possibly reduced	Reduced	Reduced	Reduced
	Moderate	Pronounced	Pronounced	Pronounced	Variable	NA
		<100	>100		Variable	NA
	≥2	≥2	>4	>4	Variable	NA

e the hierarchical order of main and additional criteria and the change of reliability of each criterion
ble are given in the text under "Main and Additional Criteria" and "Advantages of a Multiparametric
jend.
eeded to prove no flow.

ances. In case of a short neck or a bifurcation in high position, respectively, these criteria are difficult
scan head position behind the jaw angle or a scan head with a lower frequency, as for abdominal examinations, may give access to the more distal lying segments of the ICA. Another possibility is the examination of the distal ICA with 2-MHz pulsed Doppler sonography.

Criterion 6: "Reduced" means side-to-side difference, mainly in diastolic velocity.

Modified from reference 11.

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

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Main and Additional Criteria combined for Grading Internal Carotid Stenosis

Table. Combined Criteria for Grading Internal Carotid 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
8. End-diastolic flow velocity in the stenosis (cm/s)			<100	>100		Variable	NA
9. Carotid ratio ICA/CCA	<2	≥2	≥2	>4	>4	Variable	NA

These criteria do not apply for external carotid stenosis. Note the hierarchical order of main and additional criteria and the change of reliability of each criterion for different degrees of stenosis. Examples how to use this Table are given in the text under "Main and Additional Criteria" and "Advantages of a Multiparametric Approach." For definition of classes of stenosis, see Figure legend.

Criterion 1: Visualization of the ICA by B-mode imaging is needed to prove no flow.

Criterion 4a: Values taken from Figure.

Criterion 4b: Poststenotic indicates measured distal to turbulences. In case of a short neck or a bifurcation in high position, respectively, these criteria are difficult to assess with a conventional duplex technique. Then, a lateral scan head position behind the jaw angle or a scan head with a lower frequency, as for abdominal examinations, may give access to the more distal lying segments of the ICA. Another possibility is the examination of the distal ICA with 2-MHz pulsed Doppler sonography.

Criterion 6: "Reduced" means side-to-side difference, mainly in diastolic velocity.

Modified from reference 11.

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

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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 ratio ICA/CCA	<2	≥2	≥2	>4	>4	Variable	NA

to assess with a conventional duplex technique. Then, a lateral scan head position behind the jaw angle or a scan head with a lower frequency, as for abdominal examinations, may give access to the more distal lying segments of the ICA. Another possibility is the examination of the distal ICA with 2-MHz pulsed Doppler sonography.

Criterion 6: "Reduced" means side-to-side difference, mainly in diastolic velocity.

Modified from reference 11.

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

Velocità di picco sistolico (ICA PSV cm/sec)

Degree of Stenosis (%)	Primary Parameters: ICA PSV (cm/sec)	Primary Parameters: Plaque Estimate (%)*
Normal	<125	None
<50	<125	<50
50–69	125–230	≥50
≥70 but less than near occlusion	>230	≥50
Near occlusion	High, low, or undetectable	Visible
Total occlusion	Undetectable	Visible, no detectable lumen