ECHOCOLORDOPPLER LESSONS

Carotid intima-media thickness and plaque

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Carotid intima-media thickness and plaque.

INTRODUCTION

Ultrasound imaging of the far wall of the common carotid artery produces two hyperechoic parallel lines: the carotid intima-media thickness (c-IMT) corresponds to the inner and outer echogenic lines. Histologic studies have validated these lines as the lumen-intima interface and the media-adventitia interface.

The rationale of this ultrasound-based measurement is that the c-IMT is an indicator showing essential information in the very early phase of degradation, and is an independent risk factor for myocardial infarction and stroke.

The measurement of c-IMT may be with manual or methods or with automated systems: the manual measurements require rigorous quality control and are more observer dependent than automated systems.

The plaques are focal structures encroaching into the arterial lumen of at least 0.5 mm or 50% of the surrounding IMT value, or demonstrates a thickness > 1.5 mm as measured from the intima-lumen interface to the media-adventitia interface.

Several studies have indicated that plaque information relates more strongly to future cardiovascular events than c-IMT, and it is increasingly clear that c-IMT and plaque are biologically and genetically distinct phenotypes of atherosclerosis.

In this lesson the methodology of the echocolor Doppler study of c-IMT is presented.
1. US and c-IMT
2. c-IMT: how and where to measure
3. c-IMT and vascular risk
4. appropriate use criteria for c-IMT testing
5. c-IMT and plaque
6. conclusions
1. US and c-IMT
2. c-IMT how and where to measure
3. c-IMT and vascular risk
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ANATOMICAL STRUCTURE
the microscopic structure of the artery wall consists of three distinct layers:

1. INTIMA:
a single endothelial cell lining

2. MEDIA:
fibroblasts and smooth muscle with collagen support and elastic tissue

3. ADVENTITIA:
mainly composed of thick collagen fibres
ULTRASOUND PATTERN

US imaging of the far wall of the carotid artery produces two echogenic lines.
CCA IMT:
there is a correlation between anatomical structure and ultrasound pattern?
CCA IMT:
there is a correlation between anatomical structure and ultrasound pattern? **YES**

- there is a correlation between an anatomic structure an ecographic pattern of two hyperechoic parallel lines
- histologic studies have validated these lines as the lumen-intima interface and the media-adventitia interface

*P Pignoli et al. Circulation 1986*
US CAROTID INTIMA-MEDIA THICKNESS: DEFINITION

1. normal: < 0.9 mm.
2. thickening: > 0.9, < 1.4 mm.

DEFINITION FOR ULTRASOUND CHARACTERIZATION OF IMT
- a double-line pattern visualized by echography on both walls of the CCA in a longitudinal image
- two parallel lines, which consist of the leading edges of two anatomical boundaries, form it: the lumen-intima and media-adventitia interfaces

Mannheim Carotid IMT Consensus. Cerebrovasc Dis 2012
C-IMT

- US imaging of the far wall of the carotid artery produces two echogenic lines
- c-IMT corresponds to the inner and outer echogenic lines (histologic studies have validated these lines as the lumen-intima interface and the media-adventitia interface)
- the current US technology is not sensitive enough to measure the thickness of the intima alone
c- IMT of the far wall is the distance between:
- the lumen-intima interface and
- the media-adventitia interface

which corresponds to the inner and outer echogenic lines seen on the B-mode ultrasound image
THE US-BASED MEASUREMENT OF C-IMT: RATIONAL

1. the correlation US c-IMT and histology is good

2. IMT is an indicator that delivers essential information in the very early phase of degradation (atherosclerosis is the result of a long process)
1. US and IMT
2. c-IMT: how and where to measure
3. c-IMT and vascular risk
4. appropriate use criteria for IMT testing
5. c-IMT and plaque
6. conclusions
c-IMT Measurement

1. manual measure

2. automated measure: radiofrequency signals
C-IMT measurement

- diverse approaches exist, creating confusion in the literature

- the Mannheim IMT Consensus Document addresses the important issue of standardization of carotid IMT measurements and seeks to clarify problems related to the classification of early atherosclerotic lesions

*Mannheim Carotid IMT Consensus. Cerebrovasc Dis 2012*
From Mannheim CIMT Consensus. Cerebrovasc Dis 2012

**CIMT examination procedure (modified)**

- subjects in the supine position
- measuring position: CCA at least 5 mm below its end, on a 10 mm. segment of the far wall of CCA (longitudinal projection)
- c-IMT measured with an orthogonal incidence of the US beam to the axial artery course
- avoided non-linear segments, coiling or presence of plaques
- measurement on left and right side
MANNHEIM c-IMT AND PLAQUE CONSENSUS 2012

**C-IMT examination procedure**

- Longitudinal plane simultaneously demonstrating double lines on the near and far walls of the CCA
- Measuring position: at least 5 mm. from the bulb, on a 10 mm. segment of the far wall of CCA
**HOW AND WHERE TO MEASURE**

**MANHEIM c-IMT AND PLAQUE CONSENSUS 2012**

**examination procedure**

1. Arterial wall segments should be assessed in a longitudinal view, strictly perpendicular to the ultrasound beam.

2. Both walls should be clearly visualized in order to achieve diameter measurements. The optimal diameter should be obtained during diastole by automatic cineloop detection or by looking for the minimal diameter during the cardiac cycle.

US beam should be perpendicular to vessel of interest to obtain most distinct echoes:

a) US beam perpendicular to vessel wall: demonstrates trilaminar structure of arterial wall

b) US beam nonperpendicular to vessel wall: wall structure is poorly defined
MANNHEIM c-IMT AND PLAQUE CONSENSUS 2012

examination procedure

- imaging of the carotid bifurcation provides a landmark essential in serial imaging

1. CCA
2. bulb (the origin of the bulb is where near and far walls start diverging)
3. origin of ICA and ECA
C-IMT

HOW AND WHERE TO MEASURE

MANNHEIM c-IMT AND PLAQUE CONSENSUS 2012
MEASUREMENT LOCATION

- IMT should be measured preferably on the far wall of the CCA at least 5 mm below its end which avoids interindividual variability induced by physiological remodeling and less gain dependence will exist
- values from the near wall depend in part on gain settings and are less reliable

c-IMT: measuring position 1 cm from the bulb on the far wall
MANNHEIM C-IMT AND PLAQUE CONSENSUS 2012

- along 10 mm length of a straight arterial segment, a high-quality image acquisition is required for reproducible serial measurements
- in case of vessel tortuosity, IMT measurements are only possible at a shorter vessel segment, especially in the carotid bifurcation or the ICA bulb
HOW AND WHERE TO MEASURE

MANNHEIM c-IMT AND PLAQUE CONSENSUS 2012

- IMT measurements options include the mean, maximum, composite measures from both sides and different arterial sites
- mean IMT values averaged across the entire distance are less susceptible to outliers, whereas the maximal IMT may reflect more advanced stages with focal thickening or plaque formation
- the maximal value may be misleading due to the effect of measurement and sampling errors

C-IMT: the mean (yellow arrow) and maximum (red arrow) measures of CCA
HOW AND WHERE TO MEASURE

MANNHEIM c-IMT AND PLAQUE CONSENSUS 2012

examination procedure

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- c-IMT: the mean (yellow) and maximum (red) measures of CCA
C-IMT

HOW AND WHERE TO MEASURE

MANNHEIM c-IMT AND PLAQUE CONSENSUS 2012

examination procedure

- IMT values from the left and right side can be averaged although there is a significant difference between the left and right CCA IMT, with higher values on the left side.

- c-IMT values (automatic measure) from the left and right side in the same patient: the mean and maximum measures are different.
c-IMT measure: manual vs automated measure

MANNHEIM c-IMT AND PLAQUE CONSENSUS 2012

- although manual measurements may lead to valid measurements, they require rigorous quality control and quality assurance
- manual and semimanual reading methods require more time than automated systems
- automated systems can provide the mean maximal value of 150 measurements performed on a 10-mm segment of CCA instantaneously
- manual measurements are more observer dependent than semi-automatic systems

Mannheim Carotid IMT Consensus. Cerebrovasc Dis 2012
BENEFITS IN USING THE AUTOMATED MEASUREMENT FOR c-IMT

- the improved technology enhances c-IMT precision measurements
- the physician receives immediate results which consists of these parameters: maximum, mean, average and number of data points examined
- the methodology is reproducible and the measurement procedure is not operator dependent
- the mean IMT of the patient can be compared automatically with the mean IMT of the population
C-IMT imaging pitfalls
C-IMT imaging pitfalls

- this image is over-gained
C-IMT pitfalls

- this image is not aligned: in the right segment of the CCA, the two echogenic lines are lost
1. US and c-IMT
2. c-IMT how and where to measure
3. c-IMT and vascular risk
4. appropriate use criteria for c-IMT testing
5. c-IMT and plaque
6. conclusions
cardiovascular risk assessment
1. risk cards
2. c-IMT
1. risk charts and algorithm (such as Framingham or SCORE) are for estimating the probability of CV disease for individuals who have not already developed major atherosclerotic disease (measure of a patient’s CV risk)

2. risk charts are an aid to making clinical decisions about how intensively to intervene on lifestyle and whether to use drugs
In the USA the most commonly used among the risk scores is the Framingham Risk Score (FRS).

Risk for coronary heart disease events:

1. low risk individuals (10-year risk of $< 10\%$)
2. intermediate risk individuals (10-year risk of $10–20\%$)
3. high risk individuals (10-year risk of $> 20\%$)
CHD risk – low
Defined by the age specific risk level that is below average. In general, low risk will correlate with a 10-year absolute CHD risk less than 10%.

CHD risk – intermediate
Defined by the age specific risk level that is average or above average. In general, moderate risk will correlate with a 10-year absolute CHD risk between 10 and 20%. Among women and younger age men, an expanded intermediate risk range of 6–20% may be appropriate.

CHD risk – high
Defined as the presence of diabetes mellitus in a patient greater than or equal to 40 years of age, peripheral arterial disease or other coronary risk equivalents, or the 10-year absolute CHD risk of greater than 20%.

*Appropriate use criteria for carotid intima media thickness testing
The Society of Atherosclerosis Imaging and Prevention, Developed in collaboration with the International Atherosclerosis Society. Atherosclerosis 2011*
Risk Assessment Tool for Estimating 10-year Risk of Developing Hard CHD (Myocardial Infarction and Coronary Death)

The risk assessment tool below uses recent data from the Framingham Heart Study to estimate 10-year risk for "hard" coronary heart disease outcomes (myocardial infarction and coronary death). This tool is designed to estimate risk in adults aged 20 and older who do not have heart disease or diabetes. Use the calculator below to estimate 10-year risk.

Age: _______ years
Gender:
  ○ Female  ○ Male
Total Cholesterol: _______ mg/dL
HDL Cholesterol: _______ mg/dL
Smoker:
  ○ No  ○ Yes
Systolic Blood Pressure: _______ mm/Hg
  ○ No  ○ Yes

Currently on any medication to treat high blood pressure.

[Calculate 10-Year Risk]

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FRAMINGHAM RISK SCORE

- coronary heart disease (CHD) risk at 10 years in percent can be calculated with the help of the Framingham Risk Score

**Individuals with:**

1. low risk have 10% or less CHD risk at 10 years
2. intermediate risk have 10-20% CHD risk at 10 years
3. high risk have 20% or more CHD risk at 10 years
### SCORE - EUROPEAN RISK CHART

- **10 year risk of fatal CVD in Europe by gender, age, systolic blood pressure, total cholesterol and smoking status in population at high and low CV risk**
c-IMT is a predictor of future CV events?
C-IMT AND VASCULAR RISK

PROGRESSION OF IMT

- progression of IMT in asymptomatic individuals is estimated to be 0.03 mm/year

*Greenland P et al. Circulation 2000*
Relationship between age at evaluation and c-IMT in the studied cohort

Age-adjusted reference limits for c-IMT as better indicator of vascular risk: population-based estimates from the VITA project. A. Tosetto et al. J Thromb Haemost 2005
C-IMT AND VASCULAR RISK

several studies and meta-analysis have indicated that c-IMT is predictor of future CV events

I. THE ROTTERDAM STUDY. CIRCULATION 2004

Conclusions: Noninvasive measures of extracoronary atherosclerosis are strong predictors of MI. The relatively crude measures directly assessing plaques in the carotid artery and abdominal aorta predict MI equally well as the more precisely measured carotid IMT

II. GENIC. STROKE 2005

Conclusions: CCA-IMT, CPs, and FRss correlated well. The CCA-IMT value may help discriminate between subjects at low or high 10-year risk

III. A SYSTEMATIC REVIEW AND META-ANALYSIS
M.W. LORENZ CIRCULATION. 2007

meta-analysis (data from 37.197 subjects followed up for a mean of 5.5 years)

Conclusions: Carotid IMT is a strong predictor of future vascular events. The relative risk per IMT difference is slightly higher for the end point stroke than for myocardial infarction.

IV.V.VI...........................................
GUIDELINES THAT SUPPORT THE USE OF IMT FOR THE ASSESSMENT OF CV RISK:

1) ACC/AHA Guideline on the initial detection of cardiovascular risk: Recommends assessment as a class IIA (‘is reasonable to perform’) in individual at intermediate coronary heart disease risk

2) the National Cholesterol Education program Adult Treatment Panel III identified IMT as a method to detect subclinical atherosclerosis and guide selection and intensification of lipid management

3) the ESH/ESC European practice guidelines in Spain include IMT to detect target organ damage induced by hypertension

1) ACCF/AHA guideline. J Am Coll Cardiol 2010
PROGRESSION OF c-IMT

- progression of IMT in asymptomatic individuals is estimated to be 0.03 mm/year
  
  but

- this rate is accelerated in the presence of cardiovascular risk factors

c-IMT, age and risk factors

- age-related quartiles of risk factors

*Mannheim Carotid IMT Consensus. Cerebrovasc Dis 2012*
c-IMT in a young patient with familial hypercholesterolemia
the mean IMT of this patient is higher than the mean IMT of the population
C-IMT AND VASCULAR RISK

CASE REPORT

- c-IMT in a patient without CV risk
- the mean IMT of this patient is a little higher than the mean IMT of the population
C-IMT PROGRESSION

- a higher progression rate is associated with increased risk of myocardial infarction and stroke

*I. J. Kullo, FACC. J Am Coll Cardiol 2007*

C-IMT PROGRESSION

(metaanalysis: eight studies, nº 37,197 subjects, mean follow up 5.5 years)

- for an absolute CIMT increase of 0.1 mm, the future risk of:
  1. MI increased by 10–15%
  2. stroke increased by 13–18%

*Lorenz MW. 2007*
carotid IMT as indicator of CV risk:

i. c-IMT is a marker of early atherosclerosis, its anatomic extent and progression

ii. c-IMT is increased in subjects with several risk factors

iii. carotid IMT is a measure for assessing the CV risk

iv. carotid IMT is an independent risk factor for myocardial infarction and stroke
1. US and c-IMT
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6. conclusions
which patients may benefit from measurement of US c-IMT?
C-IMT AND

C-IMT: GUIDELINES AND APPROPRIATE USE CRITERIA

Society of Atherosclerosis Imaging and Prevention / International Atherosclerosis Society

C-IMT: GUIDELINES AND APPROPRIATE USE CRITERIA

1. **c-IMT appropriate use criteria**
   - appropriate indications were generally those regarding the detection of CHD risk among older patients, patients with metabolic syndrome, and patients at intermediate risk of CHD

2. **c-IMT inappropriate use criteria**
   - inappropriate indications were generally those in low-risk or high-risk patients, and all scenarios related to serial CIMT imaging

*The Society of Atherosclerosis Imaging and Prevention, Developed in collaboration with the International Atherosclerosis Society. Atherosclerosis 2011*
C-IMT: GUIDELINES AND APPROPRIATE USE CRITERIA

CIMT and plaque presence are recommended for the initial detection of CHD risk in asymptomatic patients:

- at intermediate risk
- in the setting of 2 or more NCEP (National Cholesterol Education Program) risk factors
- with metabolic syndrome
- in the setting of a family history of premature CHD
- with a known coronary artery calcium (CAC) score of zero and FRS 11–20%


*Society of Atherosclerosis Imaging and Prevention, Developed in collaboration with the International Atherosclerosis Society: Appropriate use criteria for carotid intima thickness testing. Atherosclerosis 2011*
1. US and c-IMT
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6. conclusions
US imaging can identify and differentiate

1. c-IMT:
   - an early observation of atherosclerosis

2. plaque:
   - focal, gradual process that leads to narrowing of arteries. It is a later stage of atherosclerosis (present in absence of or coincident with increased c-IMT)
DEFINITIONS FOR ULTRASOUND CHARACTERIZATION OF IMT AND ATHEROSCLEROTIC PLAQUE

*Mannheim Carotid IMT Consensus. Cerebrovasc Dis 2012*

**IMT:** a double-line pattern visualized by echography on both walls of the CCA in a longitudinal image. Two parallel lines, which consist of the leading edges of two anatomical boundaries, form it: the lumen-intima and media-adventitia interfaces.

**PLAQUES:** focal structures encroaching into the arterial lumen of at least 0.5 mm or 50% of the surrounding IMT value, or demonstrates a thickness >1.5 mm as measured from the intima-lumen interface to the media-adventitia interface.
Plaque is a focal structure encroaching into the arterial lumen:

1. of at least 0.5 mm or 50% of the surrounding IMT value
2. or demonstrates a thickness >1.5 mm as measured from the media-adventitia interface to the intima-lumen interface

*Mannheim Carotid IMT Consensus. Cerebrovasc Dis 2012*
MANNHEIM c-IMT AND PLAQUE CONSENSUS 2012

examination procedure

- longitudinal and cross-sectional views are required to visualize focal atherosclerosis
- plaque acquisition should be done along the carotid tree, in longitudinal and cross-sectional views

ICA plaque in longitudinal and transverse images: the plaque of the bulb (= 1.9 mm.) is confirmed by two different angles of insonation
MANNHEIM c-IMT AND PLAQUE CONSENSUS 2012

eexamination procedure

- color flow Doppler imaging helps to identify low echogenic boundaries

bulbar plaque in longitudinal images:
color/power Doppler imaging helps to identify low echogenic plaque
MANNHEIM c-IMT AND PLAQUE CONSENSUS 2012

examination procedure

- composite scores including both plaque and IMT should be avoided

- these composite scores including plaque (= 1.75 mm.) and IMT (= 1.24 mm. and 1.38 mm.) should be avoided
CAROTID PLAQUE: US STUDY should be considered:

1. plaque echogenicity
2. plaque surface (regular or irregular)
3. a circumferential scan ranging from anterior to posterior angles, and imaging the near or far walls of the:
   - CCA
   - bulb
   - and ICA segments
(due to the eccentric nature of plaques)
c-IMT and plaque as risk factor
several studies (the Tromsø study, the Northern Manhattan Study, the ARIC study, and others) have indicated that:

1. plaque information relates more strongly to future CV events than

2. common c-IMT
IMT AND PLAQUE

- most of the data available suggests that both plaque and c-IMT are associated with prevalent and incident CVD
- the presence of plaque, in general, has a stronger association with CVD compared to c-IMT alone
- there is no indication for measurement of IMT in patients with carotid plaque or stenosis

C-IMT AND PLAQUE AS VASCULAR RISK FACTOR

C-IMT AND PLAQUE
meta-analysis (11 population-based studies: 54,336 pts)
conclusions

- the present meta-analysis showed that the ultrasound assessment of carotid plaque, compared with that of CIMT, had a higher diagnostic accuracy for the prediction of future CAD events

Carotid plaque, compared with carotid intima-media thickness, more accurately predicts coronary artery disease events: a meta-analysis. Inaba Y et al. Atherosclerosis 2012
ASE CONSENSUS

- for the purposes of risk prediction, the American Society of Echocardiography consensus statement only considered common c-IMT measurements in the highest quartile as indicative of increased cardiovascular disease risk

*Cardiovascular Disease Risk Prediction Measures.* James H. Stein. *JAMA, December 19, 2012*
C-IMT AND PLAQUE AS VASCULAR RISK FACTOR

THE IMPORTANCE OF DISTINGUISHING BETWEEN C-IMT AND FOCAL PLAQUE

- **c-IMT** is a strong predictor of cardiovascular outcomes, but is more closely related to **left ventricular mass** than to coronary artery stenosis.
- Measurement of total **plaque** area is more strongly predictive of **stroke, death or MI** than is IMT.

- It is increasingly clear that IMT, stenosis and plaque are biologically and genetically distinct phenotypes of atherosclerosis.
- Thus US phenotypes of atherosclerosis should not be called ‘atherosclerosis’, but should be distinguished and identified individually.

*JD Spence. Can J Cardiol 2008*
c-IMT/plaque add value in 10-year risk prediction of CV disease, above that of the chart risk?
BACKGROUND

1. Risk scores such as Framingham or SCORE are extremely useful to calculate CV risk.
2. c-IMT is an alternative or a complementary way to evaluated CV risk.
3. c-IMT is an independent predictor of CV disease.

C-IMT, compared to the risk scores, has an additional value as predictor of ischemic events?
RISK PREDICTION WITH ADDITION OF c-IMT TO TRADITIONAL RISK FACTORS

(4904 individuals without pre-existing vascular disease; follow up 10 years in the CAPS Study)

- adding c-IMT to different risk prediction models, including FRS and SCORE, did not result in a significant improvement of CVD risk prediction

Lorenz MW, Schaefer C, Steinmetz H, Sitzer M. Is carotid intima media thickness useful for individual prediction of cardiovascular risk? Ten-year results from the Carotid Atherosclerosis Progression Study (CAPS). Eur Heart J 2010
C-IMT/PLAQUE AS ADDITIONAL VALUE IN CV RISK

RISK PREDICTION WITH ADDITION OF c-IMT TO TRADITIONAL RISK FACTORS

- risk calculators may integrate IMT measurement with risk factor measurements
- the ARIC study has published such a calculator incorporating IMT and plaque assessment to determine an adjusted Framingham risk
- CCAIMT ‘normal values’ in the absence of plaque should help to characterize populations at intermediate risk

ARIC Coronary Heart Disease Risk Calculator that includes Carotid Ultrasound Information

This risk assessment tool uses information from the ARIC Study. It is designed for adults, 45-65 years old, who do not have heart disease to predict a person's chance of having a heart attack in the next 10 years. To find your risk score, enter your information in the calculator below then click the 'Calculate Risk' button.

Gender
Female ☐ Male ☐

Are you a cigarette smoker?
Yes ☐ No ☐

Age
55

Total Cholesterol mg/dL
180

HDL (Good Cholesterol) mg/dL
50

Systolic Blood Pressure mm Hg
120

Carotid Artery Wall Thickness mm
* See Note below
0.80

Carotid Plaque?
Yes ☐ No ☐

Are you currently taking any medication to treat high blood pressure?
Yes ☐ No ☐

Do you have Diabetes?
Yes ☐ No ☐

- risk calculators may integrate IMT measurement with risk factor measurements
- the ARIC study; J Am Coll Cardiol has published such a calculator incorporating IMT and plaque assessment to determine an adjusted Framingham risk
C-IMT/PLAQUE AS ADDITIONAL VALUE IN CV RISK

C-IMT HAS ADDED VALUE IN RISK PREDICTION ABOVE THAT OF THE FRS?

META-ANALYSIS (45 828 individuals)

**Conclusion:** The addition of common c-IMT measurements to the Framingham Risk Score was associated with small improvement in 10-year risk prediction of first-time myocardial infarction or stroke, but this improvement is unlikely to be of clinical importance.

*Common carotid intima-media thickness measurements in cardiovascular risk prediction: a meta-analysis. Den Ruijter HM. JAMA. 2012*

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C-IMT AND PLAQUE IN RISK STRATIFICATION FOR CHD

Overall, based on the available studies, it seems that c-IMT and plaque can help **improve coronary heart disease risk** prediction, although the reported magnitude of this improvement has been variable.

*The Role of CIMT and Plaque Imaging in Risk Stratification for Coronary Heart Disease. Curr Atheroscler Rep (2012)*
LIMITATION OF THE META-ANALYSIS

- the presence of heterogeneity among the studies
- the difference in the US assessment of c-IMT and carotid plaque between studies

At present, a combination of both c-IMT measurement and an evaluation for the presence or absence of plaque seems to be the best approach
1. US and c-IMT
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THE IMPORTANCE OF DISTINGUISHING BETWEEN C-IMT AND FOCAL PLAQUE

- measurement of carotid IMT has long been regarded as a method to evaluate the burden of ‘atherosclerosis’
- however, it is increasingly clear that IMT, stenosis and plaque are biologically and genetically distinct phenotypes of atherosclerosis
- IMT is a strong predictor of cardiovascular outcomes, but is more closely related to left ventricular mass than to coronary artery stenosis
- measurement of total plaque area is more strongly predictive of stroke, death or myocardial infarction than is IMT
- thus US phenotypes of atherosclerosis should not be called ‘atherosclerosis’, but should be distinguished and identified individually

_JD Spence. Can J Cardiol 2008_
THE IMPORTANCE OF DISTINGUISHING BETWEEN C-IMT AND FOCAL PLAQUE

- c-IMT and plaques are different phenotypes indicating increased vascular risk.
- Plaque presence demonstrates a higher risk and therefore overrides IMT predictive values.
- However, IMT without plaque remains a significant marker of an increased risk of vascular events and significantly predicts plaque occurrence.
- The continuity of vascular wall changes is best monitored in CCA IMT studies, different from discontinuous focal lesions (plaque) which are characteristic of atherosclerotic disease.
- Therefore, the distinction between IMT and plaque must be clearly specified in the scanning protocols.

*Mannheim Carotid Intima-Media Thickness and Plaque Consensus. Cerebrovasc Dis 2012*
short videos and playlists on echocolor Doppler study of carotid IMT and plaque are available on my youtube channel:
http://www.youtube.com/channel/UCij561sX0bQoEjXIWKuPnKg