

Carotid Intima-Media Thickness (IMT) IAC Vascular Testing Executive Summary

A. IMT: Common Carotid Artery vs. Other Segments

Carotid IMT measurements are commonly obtained from the common carotid artery (CCA), as this vessel offers the easiest standardization due to its location, tubular shape, and parallel walls in most patients. In the Atherosclerosis Risk in Communities (ARIC) study involving carotid ultrasound examinations in 13,824 individuals, IMT measurements were obtainable from the CCA in 91.4%, from the bifurcation in 77.3%, and from the internal carotid artery (ICA) in 48.6% of participants.¹

In addition, use of the CCA IMT has correlated well with prevalent cardiovascular disease and/or outcome. In the Cardiovascular Health Study (CHS), the combination of CCA and ICA IMT resulted in similar relative risks for subsequent myocardial infarction or stroke than did CCA or ICA IMT alone (1.36 vs. 1.27 and 1.30, respectively, for 1 SD increase)². Based on the ease of imaging and the general correlation with cardiovascular disease and clinical events, use of the CCA is generally advised to measure the IMT.

Some advocate evaluation of a broader/more widespread selection of arterial segments to provide a more stable and robust prediction of risk. Therefore IMT measurements must be obtained from the far wall of the distal 1-2 cm of the CCA, and may also be obtained from the near wall of the CCA segment, as well as the near and far wall of the bifurcation, and the proximal 1 cm of the ICA.

B. IMT: Far Wall vs. Near Wall

The IMT may be measured from the near (closest to the transducer) and/or the far wall. Although measurement reproducibility of the near and far walls has been reported to be comparable³, measurement yield of the near wall is lower⁴ and accuracy may be less than that of the far wall due to technical considerations. Therefore, measurement is best obtained from the far wall of the CCA and is commonly taken from the distal 1-2 cm of the distal CCA, proximal to the flow divider⁵.

C. IMT: B-mode vs. M-mode Measurement

IMT has most commonly been measured from B-mode images. Alternatively, B-mode guided M-mode images of the distal CCA may be obtained. Whatever the method, because of the very small diameter of the intima-media layer, wall thicknesses should be measured using computer assistance with electronic calipers or semi-automated edge-detection algorithms⁶.

D. IMT: Timing of Measurement

Variations in IMT and lumen diameter must be anticipated, and therefore, electrocardiographic-gating and/or determination of minimal (end-diastolic) and maximal (peak-systolic) diameters are important components of IMT measurements. With systolic expansion of lumen diameter, obligatory thinning of IMT will occur through conservation of mass (although some degree of longitudinal stretch will occur)⁷. Therefore, measurements must be obtained at the identical timing of the cardiac cycle (preferably at end-diastole) within a particular facility so as to avoid these physiologic changes.

E. Definition of Abnormal IMT

IMT increases with age and, on average, is larger in men than women⁸. In addition, modest racial differences in IMT have been reported⁹. Thus, a single threshold value for abnormality (e.g., 1 mm) may result in systematic under-detection of abnormality in younger individuals and over-detection in older individuals. Therefore, a standardized table of IMT measurements accounting for age, gender, and race must be used to determine the true value of single IMT measurements. The extent to which carotid intimal-medial thickening is a manifestation of early or diffuse atherosclerosis, as opposed to smooth muscle hypertrophy and/or hyperplasia induced by pressure overload and/or age-related sclerosis, remains uncertain.

Internal diameter of the vessel lumen (usually the CCA) can be measured at a single point in time from B-mode

images, and determination of minimum and maximum lumen diameters is mandatory for assessment of vascular mechanics.¹⁰

F. Non-Obstructive Plaque

Plaque characterization or dimensions should not be incorporated into IMT measurements and must be reported separately in those cases where plaque is present.¹¹

- i. Plaque is defined as:
- ii. Focal structure encroaching in the lumen >0.5 mm OR
- iii. 50% of the surrounding intima-media thickness OR
- iv. Plaque thickness >1.5 mm¹²

Process

Carotid IMT measurements should be performed by technologists with training and experience in vascular ultrasound testing. IMT measurements are obtained with the patient in the supine position with the neck slightly hyperextended and the head rotated to the opposite side. High frequency ultrasound probes are used with a frequency of >7 MHz. Measurements are obtained in the distal CCA, 1-2 cm from the flow divider, in the far wall, using automated edge detection software. Measurements should be obtained from both vessels. Plaque should be reported separately from the IMT measurements. IMT measurements should ideally be reported using tables that account for age, race and gender. Facilities must submit internally validated diagnostic criteria based on their experience and published literature. In addition, facilities must develop patient education tools that will assist in educating patients on the meaning of the carotid IMT and the importance of risk factor intervention to modify cardiovascular risk.

Finally, all facilities must provide details of their internal quality assurance programs to support the performance of carotid IMT measurements.

Summary

CIMT has been effectively used as a marker of atherosclerosis in many patient populations and has also been used as a primary endpoint demonstrating therapeutic efficacy with different pharmacologic therapies. Studies using CIMT to make treatment decisions based on a single IMT measurement, with documentation of the outcome for specific interventions, for individual patients, are lacking. The IAC does not advocate use of carotid IMT as a screening method for atherosclerotic risk until further peer-reviewed literature is available. If providers choose to perform CIMT testing, rigorous methodological protocols should be strictly followed.

References

1. Arterial Wall Thickness is Associated With Prevalent Cardiovascular Disease in Middle-Aged Adults - The Atherosclerosis Risk in Communities (ARIC) Study. Burke, G., et al, *Stroke*, 1995; 26:386-391. stroke.ahajournals.org/cgi/content/full/26/3/386
2. Use of sonography to evaluate carotid atherosclerosis in the elderly. The Cardiovascular Health Study. CHS Collaborative Research Group. O'Leary, D H, et al, *Stroke*, 1991; 22:1155-1163. stroke.ahajournals.org/cgi/content/abstract/22/9/1155
3. Reproducibility of Ultrasonographically Determined Intima-Media Thickness is Dependent on Arterial Wall Thickness - The Tromsø Study. Stensland-Bugge, E., et al, *Stroke*, 1997; 28:1972-1980. stroke.ahajournals.org/content/28/10/1972.full
4. Association of Coronary Disease With Segment-Specific Intimal-Medial Thickening of the Extracranial Carotid Artery. Crouse, J., et al, *Circulation*, 1995; 92:1141-1147. www.circ.ahajournals.org/cgi/content/full/92/5/1141
5. Use of Carotid Ultrasound to Identify Subclinical Vascular Disease and Evaluate Cardiovascular Disease Risk: A Consensus Statement from the American Society of Echocardiography Carotid Intima-Media Thickness Task Force, Endorsed by the Society for Vascular Medicine. Stein, J., et al, *J Am Soc Echo*, 2008; 21:93-111. [www.onlinejase.com/article/S0894-7317\(07\)00818-8/fulltext](http://www.onlinejase.com/article/S0894-7317(07)00818-8/fulltext)
6. A New Automated Computerized Analyzing System Simplifies Readings and Reduces the Variability in Ultrasound Measurement of Intima-Media Thickness. Wendelhad, I., et al, *Stroke*, 1997; 28:2195-2200. stroke.ahajournals.org/content/28/11/2195.full
7. Conclusions on the measurement of arterial wall thickness: anatomic, physiologic and methodologic considerations. Devereux, R., et al, *J Hypertens*, 1992; 10(6):S119-S121. journals.lww.com/jhypertension/Abstract/1992/08001/Conclusions_on_the_measurement_of_arterial_wall.30.aspx
8. Carotid Plaque, Intima Media Thickness, Cardiovascular Risk Factors, and Prevalent Cardiovascular Disease in Men and Women: The British Regional Heart Study. Ebrahim, S., et al, *Stroke*, 1999; 30:841-850. stroke.ahajournals.org/cgi/content/full/30/4/841
9. Ethnic Differences in Carotid Wall Thickness - The Insulin Resistance Atherosclerosis Study. D'Agostino, R., et al, *Stroke*, 1996; 27:1744-1749. stroke.ahajournals.org/cgi/content/full/27/10/1744
10. Noninvasive measurements of arterial compliance in hypertensive compared with normotensive adults. Roman, M., et al, *J Hypertens*, 1992; 10(6):S115-S118. journals.lww.com/jhypertension/Abstract/1992/08001/Non_invasive_measurements_of_arterial_compliance.29.aspx
11. Reproducibility of Ultrasound Assessment of Carotid Plaque Occurrence, Thickness, and Morphology - The Tromsø Study. Joakimsen, O., et al, *Stroke*, 1997; 28:2201-2207. stroke.ahajournals.org/cgi/content/full/28/11/2201
12. Mannheim Carotid Intima-Media Thickness Consensus (2004-2006): An Update on Behalf of the Advisory Board of the 3rd and 4th Watching the Risk Symposium 13th and 15th European Stroke Conferences, Mannheim, Germany, 2004, and Brussels, Belgium, 2006. Touboul, P., et al, *Cerebrovasc Dis*, 2007; 23:75-80. www.karger.com/Article/FullText/97034
13. Cardiovascular risk assessment in individual patients from carotid intimal-medial thickness measurements. Riley, W., *Current Atherosclerosis Reports*, 2004; 6(3):225-231. link.springer.com/article/10.1007/s11883-004-0036-3