VASCULAR AGE AND CAROTID INTIMA – MEDIA THICKNESS

VASKULARNA STAROST I DEBLJINA INTIMO-MEDIJALNOG KOMPLEKSA KAROTIDNIH ARTERIJA

Brankica Tepavčević¹, Sandra Radak^{2,3}

Summary

Measurement of carotid intima – media thickness with B – mode ultrasound is a noninvasive and highly reproducible technique for detecting and quantifying subclinical atherosclerosis. Several large, prospective, epidemiologic studies have shown that this method accurately identifies prevalence and incidence of cardiovascular disease, independently of traditional risk factors. The value of this method is that it can be used to determine patients' vascular age. Measurement of carotid intima – media thickness reveals current atherosclerotic burden, it is feasible in a clinical setting and it can be integrated into coronary heart disease risk assessment models.

Vascular age is substitution for chronological age and it is used in order to improve coronary heart disease risk prediction taking current carotid atherosclerotic burden into account.

Key words: vascular age, atherosclerosis, cardiovascular diseases, prevention, risk factors.

Sažetak

Merenje debljine intimo-medijalnog kompleksa karotidnih arterija B modom ultrazvuka, je neinvazivna tehnika i pouzdana metoda za detekciju i kvantifikaciju subkliničke ateroskleroze. Više velikih prospektivnih epidemioloških studija pokazuju da ova metoda precizno identifikuje prevalencu i incidencu kardiovaskularnih bolesti u odnosu na tradicionalne riziko faktore. Vrednost metode je u tome što se može koristiti za određivanje vaskularne starosti bolesnika. Merenje debljine intimo-medijalnog kompleksa može nam kvantitativno pokazati aterosklerotska oštećenja, koja možemo koristiti u proceni postojećeg rizika za kardiovaskularne bolesti i proceniti vaskularnu starost svakog pacijenta. Vaskularna starost je zamena za hronološku starost i koristi se da bi se unapredilo davanje prognoze i izračunavanje rizika za oboljenje koronarnih arterija u zavisnosti od aterosklerotiskih oštećenja na karotidnim arterijama.

Ključne reči: vaskularna starost, ateroskleroza, kardiovaskularne bolesti, prevencija, faktori rizika

INTRODUCTION

Measurement of carotid intima – media thickness (CIMT) with B – mode ultrasound is a noninvasive and highly reproducible technique for quantifying atherosclerotic burden. It is a well – validated research tool, but it is not used widely as a clinical tool, even though the American Heart Association Prevention Conference V concluded that CIMT could be considered for further clarification of coronary heart disease (CHD) risk assessment (1). Several studies have demonstrated that CIMT predicts future cardiovascular events (1,2). For demonstration purposes, the Atherosclerosis Risk in Communities (ARIC) study will be focused on, because it has a well – defined scanning protocol and published data (2). In ARIC, increasing CIMT identified prevalent cardiovascular disease including angina, myocardial infarction, stroke, transient ischemic attack, and peripheral vascular disease. More importantly, the presence of increased CIMT predicted future CHD events, both for men and women (8).

Framingham CHD risk estimates are strongly influenced by chronological age; however, atherosclerotic burdens of

individuals with the same chronological age and similar risk profiles can differ substantially (1,3). An imaging test that quantifies atherosclerotic burden and that can be integrated with existing risk stratification paradigms, could be a very useful clinical tool (3).

A rich database from several clinical and epidemiologic trials, that used CIMT, provides an opportunity to adjust a patient's chronological age to their atherosclerotic burden, a concept that is called "vascular age" (8). For example, a 45 – year – old white man who has a CIMT of 0.8 mm is actually a 60 – year – old male (vascular age) based on the median CIMT value, taking sex and race into account (2,3).

Vascular health screening program should use vascular age as a part of the clinical risk prediction program. The standard imaging protocol from the ARIC study, to scan 1 – cm segments in each carotid artery, can be used. For each patient, vascular age is estimated using a statistical model on the basis of published nomograms from ARIC study using their sex, race, chronological age, and CIMT value (7).

CAROTID ULTRASOUND IMAGING

The carotid arteries were imaged with an 8.0 MHz linear array ultrasound transducer. The common carotid artery segment was defined as the distal 1 cm of the common carotid artery, immediately proximal to the origin of the bulb.

DETERMINATION OF VASCULAR AGE

Vascular age was determined by linear regression modeling using published nomograms of CIMT percentiles (5th, 10th, 25th, 50th, 75th, 90th, and 95th) according to chronological age, race and gender (6). Linear and non-linear regression models were constructed for each of the CIMT percentile functions for each carotid arterial seg-

ment. Composite CIMT values were used to determine vascular age, defined as the age at which the composite CIMT value for an individual of a given race and gender would represent the median value (50th percentile) in the ARIC study. Specifically, the linear 50th percentile function by chronological age, gender, and race was used to project the age of each subject based on their composite CIMT value. If each of a given subject's segmental CIMT values were at the 50th percentile for their chronological age, gender, and race, their composite CIMT would be at the 50th percentile and their vascular age would be equal to their chronological age. For example, a 45-year-old black female with a composite CIMT of 0.593 mm would have a CIMT percentile of 50% and a vascular age of 45 years; however, a 45-year-old black female with a composite CIMT of 0.678 mm would have a CIMT percentile

Figure 1. Age-specific percentiles of common carotid artery intima – media thickness (CCIMT) in healthy sub – population: (A) men; (B) women (9).

of 71% and a vascular age of 55 years. Finally, vascular age was substituted for chronological age in the Framingham CHD risk prediction model, resulting in modified CHD risk estimates.

DISCUSSION

The CIMT measurement can be used in conjunction with well validated and previously published population norms to determine vascular age (4). Vascular age represents an atherosclerotic burden, which varies between individuals of the same chronological age despite similar CHD risk profiles. Thus, population – based risk estimates can be modified by this direct assessment of an individual's current atherosclerotic burden. When vascular age replaced chronological age in CHD risk prediction algorithms, an estimated CHD risk was altered substantially. Evaluating atherosclerotic burden using CIMT may help individualize therapy for the primary prevention of CHD events.

Like all ultrasound techniques, determining CIMT requires training of sonographers and readers, as well as strict attention to quality control. Training programs for determining CIMT in research and clinical settings have been established. The reproducibility of this test in our clinical laboratory is similar to that reported in the literature (3-5). Since high-resolution vascular ultrasound transducers, modern ultrasound machines, and sonographers are available in most active clinical environments, the assessment of CIMT appears to be ready for mainstream use (8).

CONCLUSION

Measurement of CIMT is feasible in a clinical setting, and its use to determine vascular age can alter CHD risk assessment. Determining patients' vascular age could potentially improve the applicability of population – based CHD risk estimates to the management of an individual patient by accounting for age – related variation in atherosclerotic burden. CIMT measurement might help to identify previously unrecognized high – risk individuals and could help clinicians with better primary prevention strategies for an individual patient.

REFERENCES

1. Greenland P, Abrams J, Aurigemma GP, Bond MG, Clark LT, Criqui MH, et al. Prevention conference V: beyond secondary prevention; identifying the high-risk patient for primary prevention, noninvasive tests of atherosclerotic burden—writing group III. *Circulation* 2000;101:E16-22.
2. Bond MG, Barnes RW, Riley WA, Wilmoth SK, Chambless LE, Howard G, Owens B, ARIC Study Group: High-resolution B-mode ultrasound scanning methods in the Atherosclerosis Risk in Communities Study (ARIC). The ARIC Study Group. *J Neuroimaging* 1991;1:68-73
3. Howard G, Sharrett A, Heiss G, Evans GW, Chambless LE, Riley WA, Burke GL, for the ARIC Investigators: Carotid artery intimal-medial thickness distribution in general populations as evaluated by B-mode ultrasound. *Stroke* 1993;24:1297-1304
4. Minitab Statistical Software (Release 13.31). State College, Pa. 2001
5. Douglas PS: Atherosclerosis: It's all in the arteries. *J Am Soc Echo* 2002;15:26a
6. Stein JH, Fraizer MC, Aeschlimann SE, Nelson-Worel J, McBride PE, Douglas PS. Vascular age: integrating carotid intima-media thickness measurements with global coronary risk assessment. *Clin Cardiol* 2004;27:388-92.
7. Grundy SM. Coronary plaque as a replacement for age as a risk factor in global risk assessment. *Am J Cardiol* 2001;88:8-11E.
8. Stein JH, Fraizer MC, Aeschlimann SE, Nelson-Worel J, McBride PE, Douglas PS. Vascular age: integrating carotid intima-media thickness measurements with global coronary risk assessment. *Clin Cardiol* 2004; in press.
9. Stein JH, Fraizer MC, Aeschlimann SE, Nelson-Worel J, McBride PE, Douglas PS. Vascular age: integrating carotid intima-media thickness measurements with global coronary risk assessment. *Clin Cardiol* 2004;27:388-92.