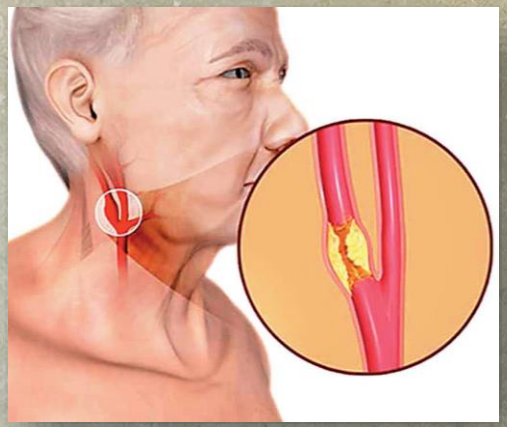
The impact of atherosclerotic changes and risk factors on cognitive status in patients with asymptomatic carotid stenosis.

Doc.Dr. Elena Simeonovska Joeva

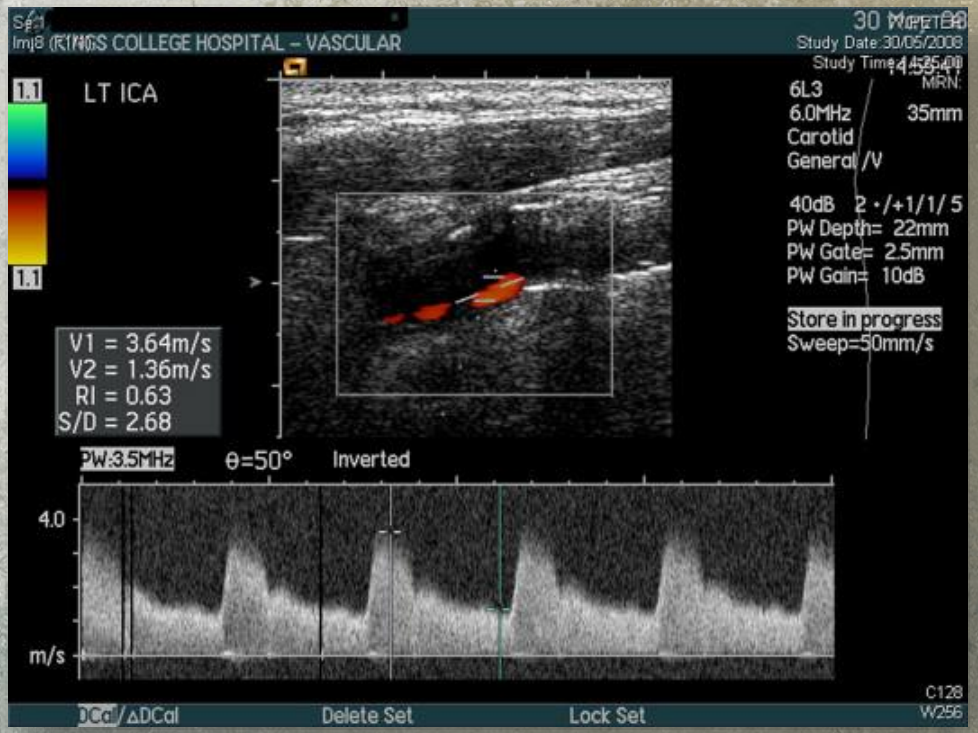
Carotid artery stenosis- Definition, prevalence and treatment

- **Carotid artery stenosis -** atherosclerotic narrowing of the proximal part of internal carotid artery, 70% in severe cases and 50% in moderate cases.
  de Weerd M, Greving JP, de Jong AW, et al. Stroke. 2009; 40:1105-13.
- **Prevalence of carotid artery stenosis in countries of Western Balkans is increasing with age**.
- New studies show a prevalence of moderate asymptomatic carotid artery stenosis in 4,2% and severe carotid artery stenosis in 1,7% .
- Ideal treatment of asymptomatic carotid artery stenosis is combination treatment of risk factors together with antiagregants. Risk factors are **hypertension, hyperlipidemia and uncontrolled glycemia.**
- Special attention is drawn to pharmacological treatment of hypertension and hyperlipidemia because they are directly affecting the carotid stenosis.



Duplex Ultrasonography as a Non-Invasive Diagnostic Method for Carotid Artery Stenosis

- Information is obtained regarding the structural characteristics of the blood vessels and the functional hemodynamic status of the brain.
- The method is of invaluable importance for monitoring and evaluating both conservative and surgical treatment of carotid diseases.

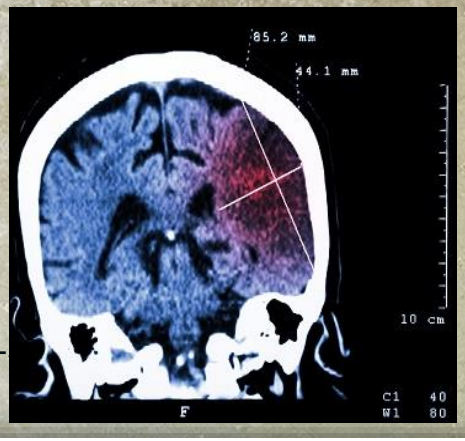


Pondexter MJ. J Cardiovasc Surg. 1991; 32:64-68.

Degree of Carotid Stenosis as a Risk Factor for Stroke and Its Association with Cognitive Impairment

- Several studies have examined the degree of carotid stenosis as a risk factor for stroke, demonstrating a significant correlation between the **severity of carotid stenosis and the occurrence of stroke**.

Zhao H, Zhao X, Liu X et al. Eur J Radiol. 2013; 82(9): e465–70.
Alagoz AN, Acar BA, Acar T, et al. Med Sci Monit. 2016; 22:4954-



- An association has been described between subclinical atherosclerosis, cognitive decline, and progression to dementia. **Increased carotid intima–media thickness**, measured by ultrasonography, has been used as a marker of atherosclerosis and a strong predictor of future vascular events. This marker has been shown to be **relevant in relation to cognitive impairment**.
- Zeki Al Hazzouri A, Newman AB, et al. Stroke. 2013; 44: 388–393

Stroke
Volume 44, Issue 2, February 2013, Pages 388-393
https://doi.org/10.1161/STROKEAHA.112.673533

ORIGINAL CONTRIBUTIONS - CLINICAL SCIENCESCLINICAL SCIENCES

Pulse Wave Velocity and Cognitive Decline in Elders

The Health, Aging, and Body Composition Study

Adina Zeki Al Hazzouri, PhD, MSc, Anne B. Newman, MD, MPH, Eleanor Simonsick, PhD, Kaycee M. Sink, MD, MAS, Kim Sutton Tyrrell, DrPH, Nora Watson, PhD, Suzanne Satterfield, MD, DrPH, Tamara Harris, MD, MS, Kristine Yaffe, MD, and for the Health ABC Study

BACKGROUND AND PURPOSE— Arterial stiffness is a measure of subclinical cardiovascular disease and increases with age. This study examines the association between arterial stiffness and cognitive decline in a cohort of older adults.

METHODS— A total of 2488 subjects with baseline measure of arterial stiffness (mean age, 74.2 years; 52.3% women) were prospectively followed over 9 years in the Health, Aging, and Body Composition Study. Arterial stiffness was measured as pulse wave velocity (PWV) and analyzed in tertiles. Cognitive function was assessed using the Modified Mini-Mental State examination at baseline and repeated at years 3, 5, 8, and 10. Lower Modified Mini-Mental State examination scores indicate worse function. We fit linear mixed models to examine longitudinal changes in cognitive function over the 9 years of follow-up and logistic regression models, restricted to 1331 participants, to examine cognitive impairment defined as a decrease of ≥5 points after 9 years. We adjusted for sociodemographics, Apoe4, and cardiovascular disease risk factors.

RESULTS— The annual decrease in Modified Mini-Mental State examination scores was 0.30 points at low PWV (95% confidence interval [CI], −0.37 to −0.22), 0.46 points at middle PWV (95% CI, −0.54 to −0.39), and 0.45 points at high PWV (95% CI, −0.53 to −0.38), from fully adjusted linear mixed models. In fully adjusted models, the odds of cognitive impairment after 9 years of follow-up was 40% greater for subjects with middle PWV (odds ratio [OR], 1.40; 95% CI, 1.03–1.92) and 59% greater for subjects with high PWV (OR, 1.59; 95% CI, 1.16–2.18), compared with low PWV.

CONCLUSIONS— High arterial stiffness was modestly associated with cognitive decline and impairment. Interventions to prevent arterial stiffness may be effective in delaying cognitive decline.

Key Words: arterial stiffness ■ cognitive impairment ■ epidemiology ■ hypertension

Degree of Carotid Stenosis as a Risk Factor for Stroke and Its Association with Cognitive Impairment

- The Core Longitudinal Study on Health and Aging (KLoSHA) analyzed the association between cardiovascular risk factors and the risk of mild cognitive impairment (MCI) and dementia over a 5-year period in older adults. A total of 448 participants were included for monitoring cognitive function, cardiovascular risk factors, and carotid intima–media thickness (IMT), with IMT measurements available for 353 participants.
- Cognitive functions were assessed using neuropsychological testing, while lifestyle factors such as smoking and alcohol consumption were also considered. Biochemical parameters—including glucose levels, lipid profiles, and degradation products—were analyzed, and ultrasonography was applied to measure carotid IMT.
- The findings demonstrated that greater intima–media thickness was associated with a higher risk of progression of cognitive dysfunction and dementia after 5 years of follow-up.

Degree of Carotid Stenosis as a Risk Factor for Stroke and Its Association with Cognitive Impairment

- **Recent studies indicate that asymptomatic carotid stenosis is associated with poor performance on neuropsychological testing**, even in cases of mild stenosis.

Johnston , 'Meara ES, Manolio TA, et al. Ann Int Med. 2004; 140(4):237–47.
Mathiesen EB, Waterloo K, Joakimsen O, et al. Neurology. 2004; 62(5):695–701.
Haley AP, Forman DE, Poppas A, et al. Int J Cardiol. 2007; 121(2):148–54.

- **Every sixth individual exhibits cognitive impairment prior to an acute cerebral infarction**.

Smith EE. Clin Sci (Lond). 2017; 131 :1059-68.

- Therefore, the **identification of risk factors provides an opportunity to prevent cognitive impairment**. Research indicates that cerebrovascular diseases play a significant role in cognitive dysfunction or dementia in patients without an apparent history of stroke.

van Veluw SJ, Zwanenburg JJ, Engelen-Lee J, et al. J Cereb Blood Flow Metab. 2013. 33:322-9.

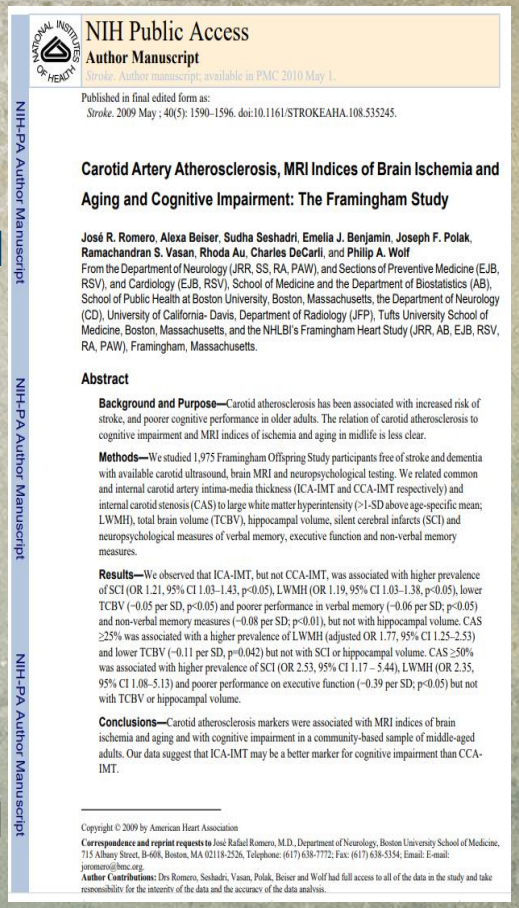
- Во студијата Framingham Offspring каротидна стеноза >50% била поврзана со поголеми оштетувања во егзекутивните функции.

Degree of Carotid Stenosis as a Risk Factor for Stroke and Its Association with Cognitive Impairment

- A study on asymptomatic carotid stenosis and cognitive function demonstrated that **asymptomatic carotid stenosis is associated with overall cognitive impairment**, independent of known vascular risk factors. Patients with stenosis exhibited poorer performance in the domains of **learning, memory, and information processing speed.**

Romero JR, Beiser A, Seshadri S, et al. Stroke. 2009; 40:1590-6.

- The study included 1,975 individuals without stroke or dementia and demonstrated that the thickness of the internal carotid artery, but not the common carotid artery, may influence both verbal and non-verbal memory. Increased intima-media thickness may contribute to specific impairments in certain cognitive domains, including executive functions, attention, and memory.
- **Patients with severe carotid artery stenosis consistently show lower scores on brief cognitive assessments** compared with those in the mild to moderate stenosis group (50–70%).



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Stroke. Author manuscript; available in PMC 2010 May 1.

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Published in final edited form as:
Stroke. 2009 May ; 40(5): 1590–1596. doi:10.1161/STROKEAHA.108.535245.

Carotid Artery Atherosclerosis, MRI Indices of Brain Ischemia and Aging and Cognitive Impairment: The Framingham Study

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From the Department of Neurology (JRR, SS, RA, PAW), and Sections of Preventive Medicine (EJB, RSV), and Cardiology (EJB, RSV), School of Medicine and the Department of Biostatistics (AB), School of Public Health at Boston University, Boston, Massachusetts, the Department of Neurology (CD), University of California- Davis, Department of Radiology (JFP), Tufts University School of Medicine, Boston, Massachusetts, and the NHLBI's Framingham Heart Study (JRR, AB, EJB, RSV, RA, PAW), Framingham, Massachusetts.

Abstract

Background and Purpose—Carotid atherosclerosis has been associated with increased risk of stroke, and poorer cognitive performance in older adults. The relation of carotid atherosclerosis to cognitive impairment and MRI indices of ischemia and aging in midlife is less clear.

Methods—We studied 1,975 Framingham Offspring Study participants free of stroke and dementia with available carotid ultrasound, brain MRI and neuropsychological testing. We related common and internal carotid artery intima-media thickness (ICA-IMT and CCA-IMT respectively) and internal carotid stenosis (CAS) to large white matter hyperintensity (>1-SD above age-specific mean; LWMH), total brain volume (TCBV), hippocampal volume, silent cerebral infarcts (SCI) and neuropsychological measures of verbal memory, executive function and non-verbal memory measures.

Results—We observed that ICA-IMT, but not CCA-IMT, was associated with higher prevalence of SCI (OR 1.21, 95% CI 1.03–1.43, p<0.05), LWMH (OR 1.19, 95% CI 1.03–1.38, p<0.05), lower TCBV (−0.05 per SD, p<0.05) and poorer performance in verbal memory (−0.06 per SD; p<0.05) and non-verbal memory measures (−0.08 per SD; p<0.01), but not with hippocampal volume. CAS ≥25% was associated with a higher prevalence of LWMH (adjusted OR 1.77, 95% CI 1.25–2.53) and lower TCBV (−0.11 per SD, p=0.042) but not with SCI or hippocampal volume. CAS ≥50% was associated with higher prevalence of SCI (OR 2.53, 95% CI 1.17 – 5.44), LWMH (OR 2.35, 95% CI 1.08–5.13) and poorer performance on executive function (−0.39 per SD; p<0.05) but not with TCBV or hippocampal volume.

Conclusions—Carotid atherosclerosis markers were associated with MRI indices of brain ischemia and aging and with cognitive impairment in a community-based sample of middle-aged adults. Our data suggest that ICA-IMT may be a better marker for cognitive impairment than CCA-IMT.

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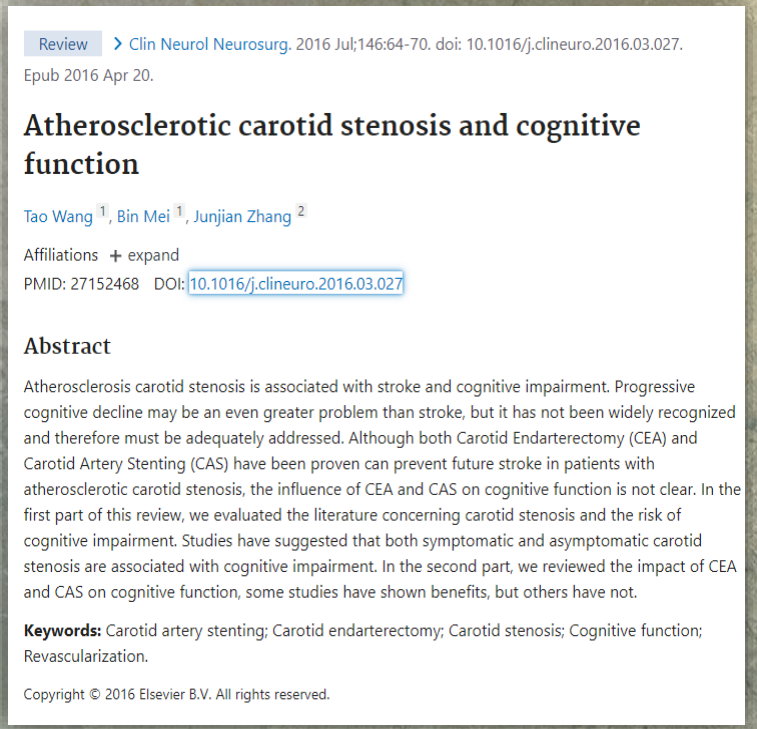
Author Contributions: Drs Romero, Seshadri, Vasan, Polak, Beiser and Wolf had full access to all of the data in the study and take responsibility for the integrity of the data and the accuracy of the data analysis.

Degree of Carotid Stenosis as a Risk Factor for Stroke and Its Association with Cognitive Impairment

Patients with bilateral carotid stenosis exhibit poorer performance in the domains of executive function, attention, and memory compared to patients with unilateral carotid stenosis.

Differences in cognitive function between patients with left and right carotid artery stenosis are not significant at high levels of stenosis, whereas at low levels of stenosis, poorer cognitive performance is observed in patients with left carotid artery stenosis.



Review › Clin Neurol Neurosurg. 2016 Jul;146:64-70. doi: 10.1016/j.clineuro.2016.03.027. Epub 2016 Apr 20.

Atherosclerotic carotid stenosis and cognitive function

Tao Wang [1], Bin Mei [1], Junjian Zhang [2]

Affiliations + expand

PMID: 27152468 DOI: 10.1016/j.clineuro.2016.03.027

Abstract

Atherosclerosis carotid stenosis is associated with stroke and cognitive impairment. Progressive cognitive decline may be an even greater problem than stroke, but it has not been widely recognized and therefore must be adequately addressed. Although both Carotid Endarterectomy (CEA) and Carotid Artery Stenting (CAS) have been proven can prevent future stroke in patients with atherosclerotic carotid stenosis, the influence of CEA and CAS on cognitive function is not clear. In the first part of this review, we evaluated the literature concerning carotid stenosis and the risk of cognitive impairment. Studies have suggested that both symptomatic and asymptomatic carotid stenosis are associated with cognitive impairment. In the second part, we reviewed the impact of CEA and CAS on cognitive function, some studies have shown benefits, but others have not.

Keywords: Carotid artery stenting; Carotid endarterectomy; Carotid stenosis; Cognitive function; Revascularization.

Wang T, Mei B, Zhang J. Clin Neurol Neurosurg. 2016. 146:64-70.

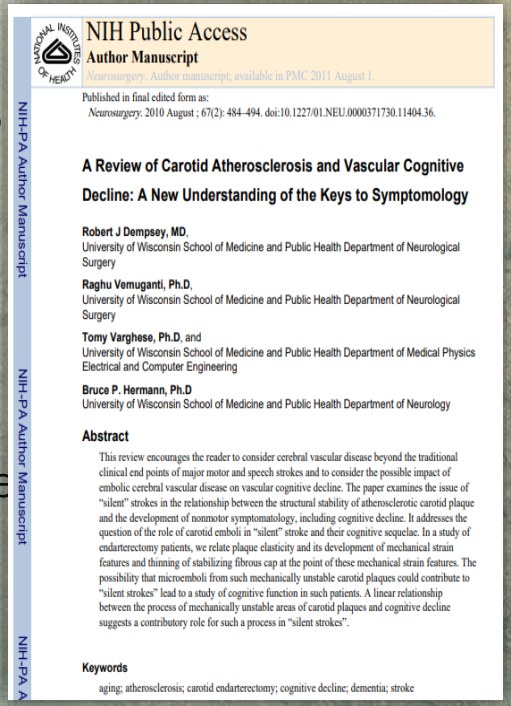
Carotid Plaques and Cognitive Impairment

Carotid plaque, its composition, and sensitive serological biomarkers are used to predict the risk of cognitive impairment.

Zhong W, Cruickshanks KJ, Huang GH, et al. Atherosclerosis. 2011; 219(1):330–3.
Carcaillon L, Plichart M, Zureik M, et al. Alzheimers Dement. 2015; 11:239-48.
Arntzen KA, Schirmer H, Johnsen SH, et al. Eur J Neurol. 2012; 19:1318-24.

- A study involving ultrasonographic assessment of 75 patients, including those with symptomatic and asymptomatic carotid atherosclerosis, demonstrated that carotid plaque is strongly associated with cognitive decline, particularly with rapid cognitive deterioration.

Dempsey RJ, Vemuganti R, Varghese T, Hermann BP. Neurosurge 2010;67:484-93



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Neurosurgery. 2010 August ; 67(2): 484–494. doi:10.1227/01.NEU.0000371730.11404.36.

A Review of Carotid Atherosclerosis and Vascular Cognitive Decline: A New Understanding of the Keys to Symptomology

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Abstract

This review encourages the reader to consider cerebral vascular disease beyond the traditional clinical end points of major motor and speech strokes and to consider the possible impact of embolic cerebral vascular disease on vascular cognitive decline. The paper examines the issue of "silent" strokes in the relationship between the structural stability of atherosclerotic carotid plaque and the development of nonmotor symptomatology, including cognitive decline. It addresses the question of the role of carotid emboli in "silent" stroke and their cognitive sequelae. In a study of endarterectomy patients, we relate plaque elasticity and its development of mechanical strain features and thinning of stabilizing fibrous cap at the point of these mechanical strain features. The possibility that microemboli from such mechanically unstable carotid plaques could contribute to "silent strokes" lead to a study of cognitive function in such patients. A linear relationship between the process of mechanically unstable areas of carotid plaques and cognitive decline suggests a contributory role for such a process in "silent strokes".

Keywords

aging; atherosclerosis; carotid endarterectomy; cognitive decline; dementia; stroke

Cerebrovascular Dysfunction and Cognitive Impairment

A reduction in cerebral blood flow by 40–50% can decrease brain activity and lead to cognitive dysfunction. Increased carotid intima–media thickness, reduced arterial elasticity, and impaired cerebral autoregulation result in decreased perfusion, thereby lowering blood flow velocity through the narrowed arterial lumen. These changes are associated with alterations in the white matter.

doi:10.1093/brain/awx112 BRAIN 2017: 140; 1987–2001 | 1987

BRAIN
A JOURNAL OF NEUROLOGY

Cerebrovascular resistance: effects on cognitive decline, cortical atrophy, and progression to dementia

Belinda Yew and Daniel A. Nation; for the Alzheimer's Disease Neuroimaging Initiative*

See Markus (doi:10.1093/awx161) for a scientific commentary on this article.

*Data used in preparation of this article were obtained from the Alzheimer's Disease Neuroimaging Initiative (ADNI) database (adni.loni.usc.edu). As such, the investigators within the ADNI contributed to the design and implementation of ADNI and/or provided data but did not participate in analysis or writing of this report. A complete listing of ADNI investigators can be found at http://adni.loni.usc.edu/wp-content/uploads/how_to_apply/ADNI_Acknowledgement_List.pdf.

Evidence for vascular contributions to Alzheimer's disease has been increasingly identified, with increased blood pressure and decreased cerebral blood flow both linked to *in vivo* biomarkers and clinical progression of Alzheimer's disease. We therefore hypothesized that an elevated ratio of blood pressure to cerebral blood flow, indicative of cerebrovascular resistance, would exhibit earlier and more widespread associations with Alzheimer's disease than cerebral blood flow alone. Further, we predicted that increased cerebrovascular resistance and amyloid retention would synergistically influence cognitive performance trajectories, independent of neuronal metabolism. Lastly, we anticipated associations between cerebrovascular resistance and later brain atrophy, prior to amyloid accumulation. To evaluate these hypotheses, we investigated associations between cerebrovascular resistance and

Ultrasound
in medicine and biology

ORIGINAL CONTRIBUTION | VOLUME 41, ISSUE 1, P64-71, JANUARY 01, 2015

Ultrasound Diagnosis of Carotid Artery Stiffness in Patients with Ischemic Leukoaraiosis

Monika Turk • Janja Pretnar-Oblak • Matija Zupan • Bojana Zvan • Marjan Zaletel

Published: October 25, 2014 • DOI: https://doi.org/10.1016/j.ultrasmedbio.2014.08.002 • Check for updates

Abstract

The pathophysiology of ischemic leukoaraiosis (ILA) is unknown. It was recently found that ILA patients have increased aortic stiffness. Carotid stiffness is a more specific parameter and could have value as a non-invasive diagnostic value for ILA. Therefore, using color-coded duplex sonography, we compared local carotid stiffness parameters of 59 patients with ILA with those of 45 well-matched controls. The diagnosis of ILA was based on exclusion of other causes of white matter changes seen on magnetic resonance imaging. Pulse wave velocity β (PWVβ, m/s), pressure–strain elasticity modulus (E_p, kPa), β index and augmentation index (A_{Ix}, %) values were higher and arterial compliance (AC, mm ^{2}/kPa) values were lower in the ILA group; however, only E_p and PWVβ reached statistical significance ($p \leq 0.05$). β, E_p and PWVβ exhibited an increasing trend with higher Fazekas score, though only E_p reached significance ($p = 0.05$). The main conclusion was that E_p and PWVβ could have a diagnostic role in patients with ILA.

Key Words

Carotid arterial stiffness • Doppler sonography • Echo tracking system • Leukoaraiosis • Vascular risk factors • White matter changes

- The study conducted at the General Hospital Štip is prospective and analyzed 180 patients aged 50 to 70 years, divided into three groups:
- Patients with asymptomatic carotid stenosis of varying degrees (without TIA or stroke).
- Patients with symptomatic stenosis (TIA or stroke).
- Control group: patients presenting with headache and vertiginous symptoms with normal findings in the carotid arteries.
- Inclusion criteria: presence of cerebrovascular risk factors, unilateral or bilateral carotid artery stenosis, presence or absence of stroke, and presence of headache or vertiginous symptoms.
- Exclusion criteria: presence of aphasia, intracerebral hemorrhage, vascular malformations, multiple sclerosis, or stroke with severity greater than NIHSS 15

The presence of hypertension, diabetes, and hypercholesterolemia was assessed. Pharmacological history, including the use of antihypertensives, statins, and antidiabetic therapy, was analyzed. Circulating levels of inflammatory markers (TNF-a) were determined from venous blood using standard immunoassays. Standard inflammation parameters—including ESR, CRP, fibrinogen, complete blood count, and leukocyte differential—were measured from venous blood.

Ultrasonographic examination included scanning of the common carotid arteries, bifurcation, and the first 2 cm of the internal carotid arteries. Carotid intima–media thickness (IMT) was measured. Arterial stenosis was categorized as follows: no stenosis/low-grade (0–50%), moderate stenosis (50–70%), and high-grade stenosis (>70%). Additionally, it was recorded whether the stenosis was unilateral or bilateral, and plaque morphology was assessed, including lipid core, fibrous cap, and their ratio

Neuropsychological Evaluation

- Cognitive functions were assessed using the Addenbrooke's Cognitive Examination (ACE-R) test

  Larner AJ, Mitchell AJ. Int Psychogeriatr. 2014; 26(4):5

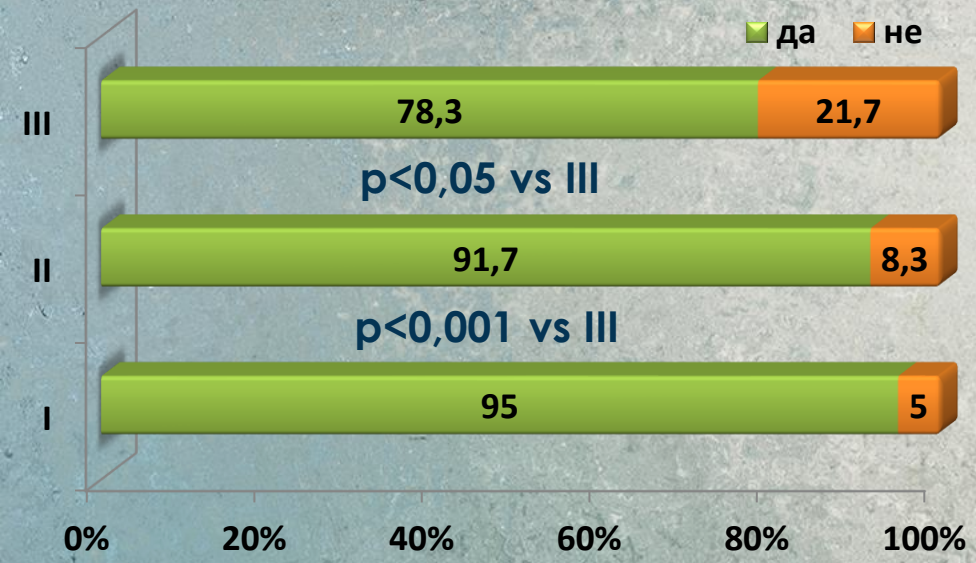
The test assesses temporal and spatial orientation, attention, calculation, speech, memory, and visuospatial abilities. It was administered six months after hospitalization in patients with symptomatic stenosis, three months after diagnosis in patients with asymptomatic carotid stenosis, and three months after evaluation in the control group presenting with headache and vertiginous symptoms.

Computed Tomography (CT): Non-contrast brain scans were performed at admission and 24–72 hours post-admission to analyze the size and location of ischemic lesions.

Magnetic Resonance Imaging (MRI): Performed six months post-event in all patients.

Stroke Severity: Assessed using the NIHSS scale: mild (<8), moderate (9–15), and severe (>16)

RISK FACTORS – HYPERTENSION



A statistically significant association was observed between hypertension and stenotic changes of varying degrees in the first patient group, $p<0.01$ ($\chi^2=7.2115$, $p=0.0072$), as well as with symptomatic stenotic changes in the second patient group, $p<0.05$ ($\chi^2=4.1830$, $p=0.0408$).

The presence of hypertension increases the likelihood of asymptomatic stenotic changes of varying degrees five-fold (OR=5.2553; 95% CI: 1.4131–19.5446), and of stenotic changes of varying degrees three-fold (OR=3.0426; 95% CI: 1.0103–9.1628)."

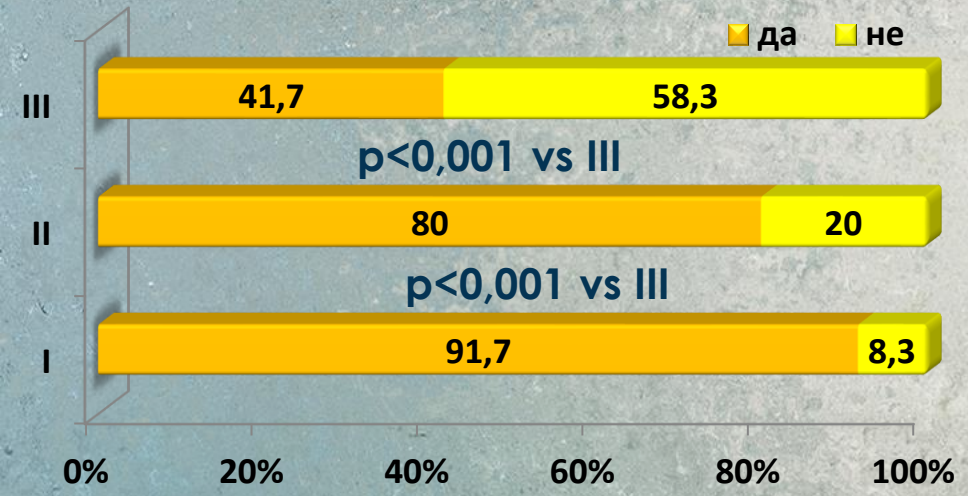
Prevalence of hypertension among the study groups (%)

A statistically significant percentage difference was established between the first and third groups ($p<0.001$), as well as between the second and third groups ($p<0.05$)

The literature indicates a significant association between hypertension and carotid atherosclerosis. Hypertension of more than 15 years' duration increases the risk of atherosclerosis by 2.5-fold and elevates the risk of stenosis of the internal carotid arteries. **Stenosis of the internal carotid artery further increases the risk of ipsilateral stroke.**

Liapis CD, et al. Stroke. 2001; 32:2782-6.

RISK FACTORS – HYPERCHOLESTEROLEMIA



Incidence of hypercholesterolemia among the study groups (%)"

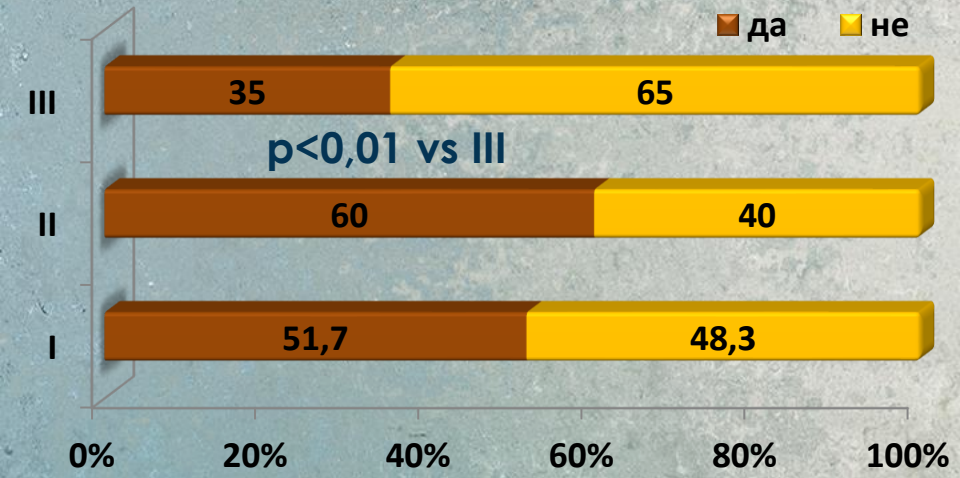
A percentage difference between Groups I and II in relation to the prevalence of hypercholesterolemia compared with Group III patients, p<0.001.

A statistically significant association was observed between the presence of hypercholesterolemia and both asymptomatic stenotic changes of varying degrees, as well as symptomatic stenotic changes (p<0.001).

The presence of hypercholesterolemia increases the likelihood of asymptomatic stenotic changes by 15-fold, and of symptomatic stenotic changes by approximately 5.5-fold.

Kaul S, et al. Ann Indian Acad Neurol. 2015; 18:430-4

RISK FACTORS – SMOKING



No statistically significant association was established between smoking and asymptomatic stenotic changes of varying degrees – $p>0.05$ ($\chi^2=3.3937$, $p=0.00654$).
A statistically significant association was established between smoking and symptomatic stenotic changes (Group II), $p<0.01$ ($\chi^2=7.5188$, $p=0.0061$).
Smoking increases the likelihood of stenotic changes of varying degrees by approximately two and a half times in the second group (OR=2.7857; 95% CI: 1.3286–5.8411).

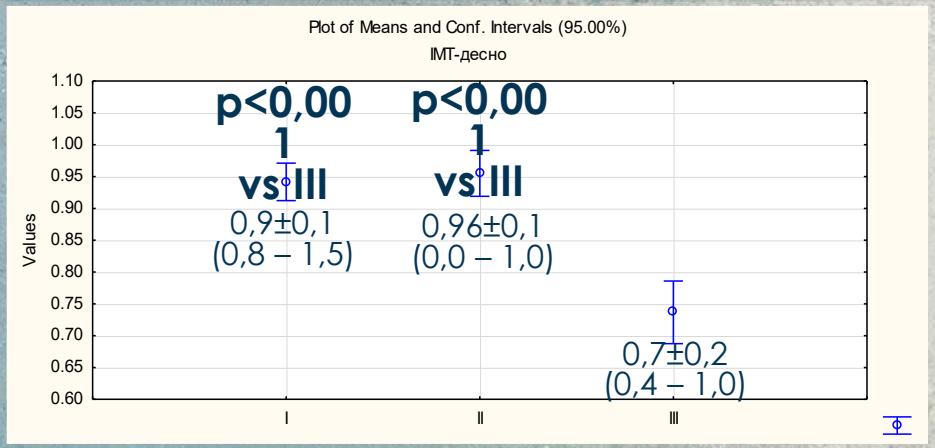
Percentage of smokers in the examined groups

There was a statistically significant difference in smoking prevalence between Group II and Group III ($p = 0.0061$)

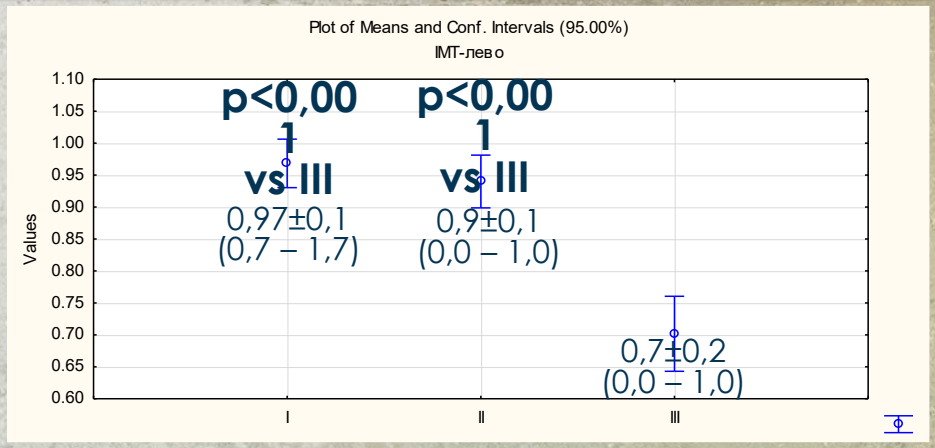
Cigarette smoking is associated with the development of cardiovascular and cerebrovascular diseases and represents one of the **modifiable risk factors.**

English JP, et al. JAMA. 1940; 115:1327–1329.
Hammond EC and Horn D. J Am Med Assoc. 1958; 166: 1294–308.

IMT (*intima media thickness*)



Presentation of the average IMT values in the examined groups (right side).



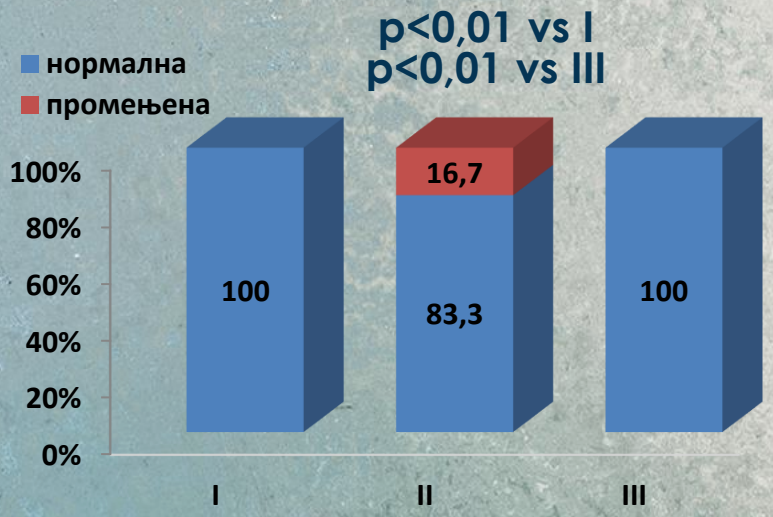
Presentation of the average BMI values in the examined groups (left side).

- **According to the Analysis of Variance (ANOVA),** the difference between the mean IMT values on the right side, as well as overall on the right, among the examined groups is statistically significant (**$p < 0.001$**).
- **According to the post hoc Tukey HSD test**, the difference is due to significant differences between **Group I and Group III**, and **Group II compared to Group III** (**$p = 0.001$**), while there is **no statistically significant difference** between **Group I and Group II**.

Neuropsychological testing

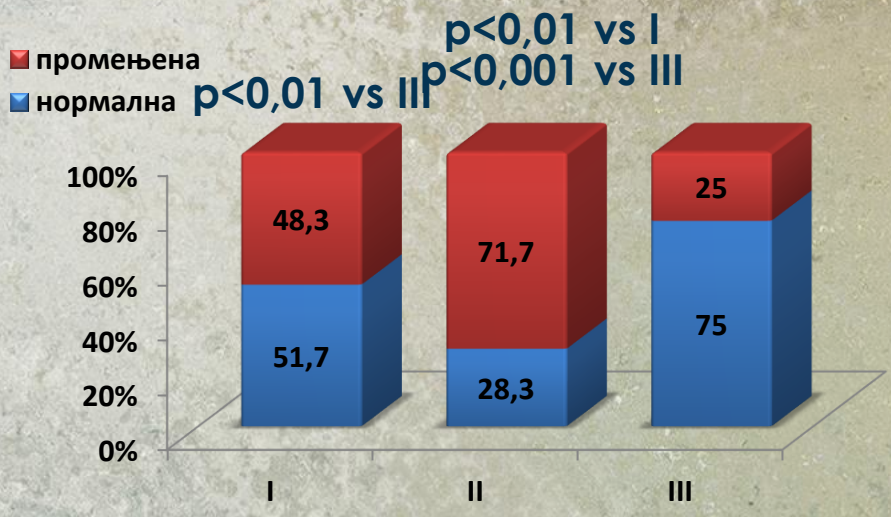
Temporal and spatial orientation

Attention



Neuropsychological testing/ Orientation in time and space

Changes in temporal and spatial orientation were observed in only 16.7% of patients in the second group with symptomatic carotid stenosis.



Neuropsychological testing/ Attention.

The difference in the frequency of attention deficits was statistically significant between Group I and Group II ($p < 0.01$), Group I and Group III (control) ($p < 0.01$), as well as between Group II and Group III ($p < 0.001$).

Neuropsychological Testing

Cognitive dysfunctions manifest as measurable impairments in various activities, skills, knowledge, and intellectual abilities

Cadlovski G, et al. Medicinska psihologija. 2004; 43-47, 70-74, 74-83, 86.

There are specific scales for assessing hippocampal function (speech and memory), as well as temporal or frontal lobe function, which allow for precise neuropsychological mapping of brain lesions. Results from the study by Tomlinson et al. suggest that **the size of a stroke lesion correlates with the occurrence of cognitive impairments**. A stroke can lead to vascular dementia when the lesion size exceeds 100 ml.

The research by Zekry and colleagues suggests that total stroke volume can explain only a small portion of the variability in cognition among stroke patients. It further indicates that **infarcts in strategic regions—such as cortical and limbic areas, the frontal cortex, and white matter—play a crucial role in the mechanism of cognitive impairment and are associated with the severity of dementia.**

Zekry D, et al.. Neurobiol Aging. 2003; 24:213-9.

"From our study, the following conclusions were drawn regarding the correlation between risk factors, carotid stenosis, and cognitive impairment :

- In patients with asymptomatic carotid stenosis, there is a statistically significant correlation between cognitive status and the degree of carotid stenosis. High-grade stenosis (>70%) of the right carotid artery increases the likelihood of moderate cognitive impairment sixfold compared to low-grade stenosis, while high-grade stenosis (>70%) of the left carotid artery increases the likelihood of moderate cognitive impairment twentyfold compared to low-grade stenosis.
- A statistically significant association was observed between certain risk factors (hypertension and hypercholesterolemia) and asymptomatic carotid stenosis of varying degrees. Cognitive status is poorer in stroke patients who also have asymptomatic carotid stenosis.

Conclusion

- A correlation between carotid stenosis of varying degrees and cognitive impairment has been confirmed. Additionally, certain vascular and inflammatory risk factors exert differential effects on the development of carotid stenosis and, indirectly, on cognitive decline.
- An interdisciplinary approach involving internists and psychiatrists is necessary for all patients with cardiovascular and cerebrovascular diseases. Primary prevention, including early diagnosis of vascular risk factors, is essential with the ultimate goal of reducing morbidity and mortality from cerebrovascular disease and preventing the development of dementia.