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The impact of asymptomatic carotid stenosis on cognition

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ABSTRACT

Aims: Asymptomatic carotid stenosis (ACS), characterized by the narrowing of carotid arteries without evident symptoms, has been increasingly associated with cognitive decline, particularly in memory and executive functions. This study investigates the cognitive implications of ACS by evaluating cognitive performance using the Mini-Mental State Examination (MMSE) and the Montreal Cognitive Assessment (MoCA).

Methods: This retrospective study included 20 ACS patients, and 15 matched healthy controls. Participants were recorded for cognitive status, age, gender, and educational background to ensure group comparability. MMSE and MoCA were used for cognitive assessment.

Results: The findings revealed that while MMSE scores did not differ significantly between groups, MoCA scores were notably lower in ACS patients (19.85 ± 4.68) compared to controls (23.07±3.01, p=0.027), suggesting pronounced cognitive deficits in domains such as visuospatial ability and delayed recall. These results align with existing literature indicating that ACS may impair cerebral blood flow and disrupt connectivity in key neural networks, thereby contributing to cognitive impairment. Additionally, while the ACS group tended to be older and have fewer years of formal education, these factors did not significantly confound the observed cognitive differences (p<0.05).

Conclusion: Our results underscore the importance of routine cognitive evaluations in patients with ACS, as traditional assessments may underestimate their impact on brain health. Future research should explore the efficacy of interventions such as carotid endarterectomy or stenting in mitigating cognitive decline associated with ACS. These findings advocate for a holistic approach to managing ACS, integrating cognitive assessments alongside traditional cardiovascular risk evaluations to enhance patient outcomes and quality of life.

Keywords: Asymptomatic carotid stenosis, cognition, MOCA, MMSE

INTRODUCTION

Asymptomatic carotid stenosis (ACS), characterized by the narrowing of the carotid arteries without significant symptoms, poses a substantial risk not only for cerebrovascular events but also for cognitive decline.[1] This phenomenon has garnered attention in recent research due to its potential implications for memory and overall cognitive function. Understanding the relationship between ACS and memory is crucial as it highlights the intricacies of vascular health and neurocognitive processes. The absence of overt symptoms can lead to a troubling underestimation with moderate to severe stenosis found notable deficits in cognitive functions, particularly in domains such as the executive functions independent of the vascular stenosis condition's seriousness, allowing it to progress unchecked.[2] The cognitive importance of ACS makes investigating the underlying mechanisms that connect arterial blockages to cognitive impairments substantial, especially regarding the impacts of silent vascular changes on memory, which is vital for developing effective treatment and preventive interventions.[1]

Current research suggests that individuals with this condition may experience subtle cognitive impairments, such as deficits in memory and information processing speed. For instance, a study indicated that cognitive impairment was prevalent among patients with severe ACS, with 72% suffering from memory issues before intervention.[3] This result is not only seen in carotid stenosis but also in carotid plaques, which are strongly linked with significant cognitive decline, especially in memory and visuospatial abilities assessed through standardized neuropsychological tests.[4] Furthermore, this decline in cognitive function occurs independently of clinically evident cerebrovascular incidents, positioning ACS as a potential risk factor for dementia.[5] In addition, declines in working memory linked to both severe carotid stenosis and conditions like Alzheimer's disease (AD)[6] underscore the critical relationship between cerebral health and cognitive capacity. Moreover, recent studies indicate that also patients with no AD but with significant stenosis exhibit notable impairments in executive functions, memory, and emotional state, underscoring a correlation between high-grade and bilateral stenosis with cognitive deterioration.[2,7,8] Advanced carotid disease is not only linked to a heightened risk of cerebrovascular events. Still, it may also precipitate cognitive decline independent of symptomatic occurrences, suggesting clinicians need to evaluate cognitive status routinely during assessments.[5,7] Within that context, utilizing functional magnetic resonance imaging (fMRI) to investigate these dynamics has shown that cognitive interventions may yield improvements in brain activation patterns, suggesting that targeted treatments could mitigate some cognitive deficits associated with carotid stenosis.[8] Besides the high-tool imaging tools, evaluating the clinical memory impairment in patients with ACS is critical, given the potential above-mentioned cognitive deficits associated with this condition.[4,9]

Among the most widely used cognitive screening tools, the Montreal Cognitive Assessment (MoCA)[10] and the Mini-Mental State Examination (MMSE)[11] provide valuable insights into different cognitive domains. The MoCA is a 30-point test designed to assess visuospatial and executive function, attention, language, memory, and orientation, with a strong sensitivity for detecting mild cognitive impairment. In contrast, the MMSE is an 11-question screening tool that evaluates five key cognitive areas: orientation, registration, attention and calculation, recall, and language. A total score below 24 on the MMSE is generally indicative of cognitive impairment. These tests, commonly used in research and clinical practice, allow for early detection of cognitive decline and facilitate monitoring disease progression, making them critical in studies assessing cognitive function in ACS patients.

To raise clinicians' awareness, incorporating comprehensive assessments that measure these cognitive domains along with imaging methods allows for a better understanding of the cognitive implications of ACS. This approach ultimately guides therapeutic interventions and improves patient outcomes. In the present study, we aimed to evaluate the relationship between ACS and cognition.

METHODS

We searched the hospital database for a group sample with a carotid Doppler ultrasound report and cognitive tests performed. A total of 20 patients were enrolled with sociodemographic factors (age, gender, and years of education). Additionally, 15 healthy subjects were matched for cognitive assessment and demographic variables. Alanya Training and Research Hospital Ethical Committee approved the study (Date: 22.01.2025, Decision No: 02-02). All procedures were carried out in accordance with the ethical rules and the principles of the Declaration of Helsinki.

Patients with ≥50% carotid stenosis on carotid Doppler ultrasound were included in the study. Exclusion criteria were: 1) history of brain trauma or operation; 2) accompanying neuropsychiatric diseases and being used drugs which may affect the cognitive status (e.g., antidepressants); 3) electrolyte or metabolic imbalance (e.g., vitamin B12, vitamin B9, thyroid functions); 4) a history of stroke, transient ischemic attack, or carotid endarterectomy.

The MoCA, a 30-point test, evaluates various cognitive domains, including visuospatial and executive function, abstraction, and delayed recall.[12] The MMSE, another widely used cognitive screening tool, was also administered to all participants. It is an 11-question measure that tests five areas of cognitive function: orientation, registration, attention and calculation, recall, and language. The maximum score is 30 points. A score of 23 or lower is indicative of cognitive impairment.[13]

Statistical Analysis

IBM SPSS Statistics software (version 22) was used in the data analysis. Continuous parameters are expressed as the mean and the standard deviation (SD), and categorical parameters are shown as numbers and frequencies (%). Data were tested for normal distribution using the Shapiro-Wilk test. Normally distributed data were analyzed with one-way ANOVA, Student's t-test, and Pearson's correlation, while non-normally distributed data were analyzed with a Mann–Whitney U test, Kruskal Wallis, and Spearman's test. Also, categoric variables were analyzed using Fisher's exact test. Two-sided p-values and 95% CIs were used in SPSS software. Significance was determined at $p<0.05$.

RESULTS

This study compared patient and control groups' cognitive performance, age, and educational background. Twenty patients and 15 healthy individuals participated in the study. Ten female patients were in the patient group, and five were in the control group (χ^2:0.972, p= 0.324, Table 1).

Table 1. Demographic and clinical variables in the participants

Variables	ACS (n=20)	Controls (n=15)	p
Gender (female, n, %)	10 (50)	5 (33)	0.324 (χ^2: 0.972)
Age	66.15±12.15	60±9.17	0.11
Years of education	6.15±4.21	8.73±5.18	0.16
MMSE	25.85±2.28	26.8± .93	0.19
MoCA	19.85±4.48	23.07±3.01	0.028*

MMSE: Mini-Mental State Examination, MoCA: The Montreal Cognitive Assessment, n: Number. Results have been presented as mean±standard deviation, p significance level: <0.05

The MMSE scores were slightly lower in the patient group (25.85±2.28) compared to the control group (26.80±2.93); however, this difference was not statistically significant (p=0.28, Table 1). In contrast, the MoCA scores, which provide a more detailed evaluation of cognitive abilities, were significantly lower in the patient group (19.85±4.68) than in the control group (23.07±3.01; p=0.027, Table 1). This finding highlights a distinct disparity in MoCA, suggesting that carotid stenosis exhibited more significant impairments in cognitive performance.

There was no correlation between right or left carotid stenosis and cognitive tests in the patient group (Table 2). Patients'

Table 2. The correlation analyses in individuals with asymptomatic carotid stenosis

	2	3	4	5	6 (MoCA)
(1) right carotid stenosis (%)	-0.239 0.310	-0.017 0.943	-0.052 0.827	-0.074 0.756	-0.219 0.353
(2) left carotid stenosis (%)		0.328 0.158	-0.472 0.035*	-0.122 0.607	-0.181 0.446
(3) Age			-0.428 0.060	-0.496 0.026*	-0.665 0.001*
(4) Education years				0.381 0.097	0.634 0.003*
(5) MMSE					0.615 0.004*

MMSE: Mini-Mental State Examination; MoCA: The Montreal Cognitive Assessment; n: Number. The results have been presented as r (correlation coefficient) and p values*p<0.05: significance level

ages were negatively correlated with cognitive tests, as expected.

Although the patient group was nonsignificant (p=0.11, Table 1), it was, on average, older (66.15±12.15) than the control group (60±9.17).

Educational background, assessed through years of formal education, showed a trend toward lower values in the patient group (6.15±4.21) compared to the control group (8.73±5.18). However, this difference was not statistically significant (p=0.113, Table 1), indicating that the groups were relatively comparable in terms of educational attainment.

DISCUSSION

We have found that patients with ACS had lower cognitive function than controls. The findings from our study contribute to the growing body of evidence suggesting that ACS may not be as clinically silent as previously thought, particularly in relation to cognitive function. Our results align with several recent studies demonstrating a significant association between ACS and cognitive impairment.[14-16]

Interestingly, our findings reveal that patients with ACS exhibit poorer performance in global cognition, memory, and executive function compared to healthy controls.[16] The MoCA scores were significantly lower in the ACS group, suggesting more pronounced impairments in cognitive domains such as visuospatial ability, executive function, and delayed recall. In contrast, while MMSE scores were lower in the patient group, the difference was not statistically significant. This discrepancy may be attributed to the greater sensitivity of the MoCA test in detecting mild cognitive impairment, particularly in executive functions, which are often affected early in vascular cognitive decline. The MMSE, while widely used, primarily assesses orientation, memory, and basic cognitive functions and may not be as effective in capturing subtle cognitive deficits associated with ACS. This cognitive decline appears to be linked to cerebral hemodynamic impairment, as evidenced by decreased cerebral blood flow in specific brain regions and reduced connectivity in the default mode network.[16] These observations are further supported by studies showing that patients with ACS and impaired cerebrovascular reserve demonstrate significant cognitive impairment compared to those with normal reserve.[14] However, it is essential to note that the relationship between ACS and cognitive impairment is complex and may involve multiple mechanisms. While some studies have identified older age and cerebral hypoperfusion as additional factors contributing to cognitive decline in ACS patients[15], others have observed diffuse white matter abnormalities and localized grey matter atrophy in the ipsilateral hemisphere.[17] Furthermore, although differences in age and educational background between groups were not statistically significant, the trends observed suggest that these factors may still play a role in cognitive performance. Older age and lower educational attainment, both more prevalent in the ACS group, are well-established risk factors for cognitive decline and may have influenced the observed cognitive differences.

Under the our findings, it would be assumed that the cognitive effects of ACS may be more widespread than previously thought and not limited to the territory of the stenosed artery. This has important implications for the management of ACS patients, as cognitive function may need to be considered alongside traditional stroke risk factors when making treatment decisions.[18,19] Future research should focus on longitudinal studies to better understand the progression of cognitive decline in ACS and evaluate the potential cognitive benefits of interventions such as carotid endarterectomy or stenting.[16,20]

CONCLUSION

In conclusion, the exploration of ACS reveals critical insights into its potential impact on cognitive function and overall patient well-being. Our results, in conjunction with existing literature, strongly suggest that ACS is associated with cognitive impairment and should not be considered truly asymptomatic. While initially deemed benign, research indicates that individuals with ACS may experience notable cognitive impairments affecting memory, executive functions, and psychological dimensions. All of the complexity suggests that asymptomatic status may be misleading, warranting a re-evaluation of how these patients are assessed and managed. As the relationships between vascular health, cognition, and emotional states become clearer, clinicians must consider comprehensive evaluations for ACS patients to address cognitive decline and mental health effectively, ultimately improving patient outcomes.

To sum up, our results suggest that while the patient group demonstrated significantly poorer cognitive performance on the MoCA test, other factors such as age and education may also play a role, albeit somewhat. Further studies are needed to disentangle these factors and their impact on cognitive function. These findings suggest that cognitive assessment should be integrated into managing patients with carotid stenosis, as ignoring these cognitive impairments could overlook critical aspects of patient health and impede appropriate intervention strategies.

ETHICAL DECLARATIONS

Ethics Committee Approval

Alanya Training and Research Hospital Ethical Committee approved the study (Date: 22.01.2025, Decision No: 02-02).

Informed Consent

Because the study was designed retrospectively, no written informed consent form was obtained from patients.

Referee Evaluation Process

Externally peer-reviewed.

Conflict of Interest Statement

The authors have no conflicts of interest to declare.

Financial Disclosure

The authors declared that this study has received no financial support.

Author Contributions

All of the authors declare that they have all participated in the design, execution, and analysis of the paper, and that they have approved the final version.

REFERENCES

1. Johnston SC, O'Meara ES, Manolio TA, et al. Cognitive impairment and decline are associated with carotid artery disease in patients without clinically evident cerebrovascular disease. *Ann Intern Med.* 2004;140(4):237-247. doi:10.7326/0003-4819-140-4-200402170-00005
2. Everts R, Wapp M, Burren Y, et al. Cognitive and emotional effects of carotid stenosis. *Swiss Med Wkly.* 2014;144:w13970. doi:10.4414/smw.2014.13970
3. Ortega G, Alvarez B, Quintana M, Yugueros X, Alvarez-Sabin J, Matas M. Asymptomatic carotid stenosis and cognitive improvement using transcervical stenting with protective flow reversal technique. *Eur J Vasc Endovasc Surg.* 2014;47(6):585-592. doi:10.1016/j.ejvs.2014.02.022
4. Landgraff NC. Cognitive and physical performance in patients with asymptomatic carotid artery stenosis and occlusion. University of Pittsburgh; 2004.
5. Martinic-Popovic I, Lovrencic-Huzjan A, Demarin V. Advanced asymptomatic carotid disease and cognitive impairment: an understated link? *Stroke Res Treat.* 2012;2012(1):981416. doi:10.1155/2012/981416
6. Vitali F, Torrandell-Haro G, Branigan G, et al. Asymptomatic carotid artery stenosis is associated with increased Alzheimer's disease and non-Alzheimer's disease dementia risk. *Stroke Vasc Neurol.* 2024:svn-2024-003164. doi:10.1136/svn-2024-003164
7. Sztriha LK, Nemeth D, Sefcsik T, Vecsei L. Carotid stenosis and the cognitive function. *J Neurol Sci.* 2009;283(1-2):36-40. doi:10.1016/j.jns.2009.02.307
8. Chinda B. Task-phase fMRI in detection of improvements in working memory post-interventions for carotid stenosis and early Alzheimer's disease. 2021.
9. Durmaz Çelik FN, Aykaç Ö. The effect of asymptomatic carotid artery stenosis on cognitive functions. *Turkish J Cerebrovasc Dis.* 2019;25(3):140-144. doi:10.5505/tbdhd.2019.14890
10. Nasreddine ZS, Phillips NA, Bédirian V, et al. The Montreal Cognitive Assessment, MoCA: a brief screening tool for mild cognitive impairment. *J Am Geriatr Soc.* 2005;53(4):695-699. doi:10.1111/j.1532-5415.2005.53221.x
11. Cockrell JR, Folstein MF. Mini-mental state examination. Principles and Practice of Geriatric Psychiatry. 2nd Edition. 2002.
12. Nasreddine ZS, Phillips NA, Bédirian V, et al. Montreal cognitive assessment. *Am J Geriatr Psychiatry.* 2011;53(4):695-699. doi:10.1037/t27279-000
13. Folstein MF, Folstein SE, McHugh PR. "Mini-mental state": a practical method for grading the cognitive state of patients for the clinician. *J Psychiatr Res.* 1975;12(3):189-198. doi:10.1016/0022-3956(75)90026-6
14. Bhandari A, Feridooni T, Pikula A, Styra R, Mikulis DJ, Howe KL. Evaluating the influence of altered cerebral hemodynamics on cognitive performance in asymptomatic carotid artery stenosis: a systematic review. *J Vasc Surg.* 2024;79(2):436-447. doi:10.1016/j.jvs.2023.08.111
15. Chang X-L, Zhou H-Q, Lei C-Y, et al. Association between asymptomatic carotid stenosis and cognitive function: a systematic review. *Neurosci Biobehav Rev.* 2013;37(8):1493-1499. doi:10.1016/j.neubiorev.2013.05.011
16. Wang T, Sun D, Liu Y, et al. The impact of carotid artery stenting on cerebral perfusion, functional connectivity, and cognition in severe asymptomatic carotid stenosis patients. *Front Neurol.* 2017;8:403. doi:10.3389/fneur.2017.0040317
17. Avelar WM, D'Abreu A, Coan AC, et al. Asymptomatic carotid stenosis is associated with gray and white matter damage. *Int J Stroke.* 2015;10(8):1197-1203. doi:10.1111/ijs.12574
18. AbuRahma AF. The new 2023 European Society for Vascular Surgery (ESVS) carotid guidelines: the transatlantic perspective. *Eur J Vasc Endovasc Surg.* 2023;65(1):5-6. doi:10.1016/j.ejvs.2022.06.001
19. Kim J-G, Kang C-H, Choi JC, Song Y, Suh DC, Lee DH. Clinical outcomes of endovascular treatment for carotid artery dissection without intracranial large vessel occlusion in patients with cerebral ischemia presentation. *Front Neurol.* 2022;12:713190. doi:10.3389/fneur.2021.713190
20. Gaba K, Ringleb PA, Halliday A. Asymptomatic carotid stenosis: intervention or best medical therapy? *Curr Neurol Neurosci Rep.* 2018;18(11):80. doi:10.1007/s11910-018-0888-5