ScientificScholar®
Knowledge is power
Publisher of Scientific Journals

www.surgicalneurologyint.com

Surgical Neurology International

Editor-in-Chief: Nancy E. Epstein, MD, Clinical Professor of Neurological Surgery, School of Medicine, State U. of NY at Stony Brook.

SNI: Neurovascular

Editor
Kazuhiro Hongo, MD
Shinshu University, Matsumoto, Japan

SNI
Open Access

Original Article

Importance of preoperative coronary artery examination before performing procedures for carotid artery stenosis

Takanori Uchida, Ryuzaburo Kanazawa, Tetsuhiro Higashida, Saiko Watanabe, Takao Kono

Department of Neurosurgery, Nagareyama Central Hospital, Nagareyama, Chiba, Japan.

E-mail: *Takanori Uchida - uchida01321@gmail.com; Ryuzaburo Kanazawa - r.kanazawa@nch.or.jp; Tetsuhiro Higashida - tets018@gmail.com; Saiko Watanabe - swneurosurg@gmail.com; Takao Kono - t2kohno@marianna-u.ac.jp

***Corresponding author:**
Takanori Uchida,
Department of Neurosurgery,
Nagareyama Central Hospital,
Nagareyama, Chiba, Japan.

uchida01321@gmail.com

Received : 11 April 2023
Accepted : 16 June 2023
Published : 30 June 2023

DOI
10.25259/SNI_324_2023

Quick Response Code:

ABSTRACT

Background: Carotid artery stenosis and coronary artery disease (CAD) often occur simultaneously, with one being an important risk factor in the treatment of the other. This study aimed to perform coronary computed tomography angiography (CTA) as a preoperative evaluation for carotid artery stenosis treatment.

Methods: We retrospectively reviewed cases of carotid endarterectomy (CEA) and carotid artery stenting (CAS) performed at our hospital as well as CAD complications.

Results: Among the 54 and 166 CEA and CAS cases from May 2014 to February 2022, 53 and 148 cases were analyzed for atherosclerotic stenosis, respectively. Among those who underwent CEA and CAS, 7 (13.2%) and 17 (11.5%) received percutaneous coronary intervention (PCI), 44 (83%) and 97 (65.5%) received symptomatic carotid stenosis treatment and 43 (81.1%) and 110 (74.3%) received preoperative coronary CTA, respectively. Coronary artery stenosis was noted in 14 (32.6%) and 46 (41.8%) patients who had undergone CTA in the CEA and CAS groups, respectively. PCI before carotid treatment was performed in two cases in the CEA group (3.8% of all patients who had undergone CEA) and eight cases in the CAS group (5.4% of all patients who had undergone CAS).

Conclusion: Screening may detect asymptomatic coronary artery lesions in carotid artery stenosis even in patients without chest symptoms and suspicion of ischemic heart disease. Preoperative coronary artery screening is important considering that pre and postoperative coronary artery treatment may improve long-term prognosis.

Keywords: Carotid artery stenosis, Carotid artery stenting, Carotid endarterectomy, Coronary artery disease, Coronary computed tomography angiography

INTRODUCTION

In general, atherosclerotic diseases, including carotid artery stenosis, are strongly associated with systemic vascular lesions, with coronary artery disease (CAD) being particularly common. However, both carotid artery stenosis and CAD are individually important risk factors in the treatment of the other. We have experienced cases of myocardial infarction during the perioperative period of carotid artery stenosis treatment and have since performed coronary computed tomography angiography (CTA) for preoperative evaluation. In the present study, we retrospectively reviewed cases of carotid endarterectomy (CEA) and carotid artery stenting (CAS) performed at our hospital as well as CAD complications.

MATERIALS AND METHODS

Among the 54 and 166 cases who had undergone CEA and CAS from May 2014 to February 2022, 53 and 148 cases were analyzed, respectively, excluding those who had undergone internal carotid artery dissection, acute revascularization, and revision after CAS.

Coronary CTA was preoperatively performed but not in cases with nonatherosclerotic lesions, such as those requiring internal carotid artery dissection, cases in which the patient had already visited another hospital for cardiac examination and treatment, cases who had already undergone retreatment for carotid artery stenosis, and cases in which performing necessary respiratory pause during imaging was difficult due to cognitive impairment.

RESULTS

The characteristics of the included patients are summarized in Table 1. The CEA group consisted of 53 patients (mean age: 75.1 ± 9.1 years), including 47 males (88.7%, mean age: 74.7 ± 9.3 years) and 6 females (11.3%, mean age: 78.5 ± 7.1 years). The CAS group consisted of 148 patients (mean age: 74.7 ± 7.3 years), including 136 males (91.9%, mean age: 74.9 ± 7.3 years) and 12 females (8.1%, mean age: 72.8 ± 7.1 years). Both the CEA and CAS groups had more males than females. Among those in the CEA and CAS groups, 44 (83%) and 97 (65.5%) were treated for symptomatic carotid artery stenosis, respectively, with the CEA group having a greater proportion of cases. Preoperative coronary CTA was performed in 43 (81.1%) and 110 (74.3%) patients in the CEA and CAS groups, respectively. Among those who had undergone CTA, 14 (32.6%) and 46 (41.8%) in the CEA and CAS group showed abnormalities during CTA, respectively. Coronary artery lesions and symptomatic carotid artery stenosis were observed in 11 of 14 patients in the CEA group and 34 of 46 patients in the CAS group. Moreover, 7 (13.2%) and 17 (11.5%) patients in the CEA and CAS groups had a history of percutaneous coronary intervention (PCI), respectively.

Table 1: Patient characteristics.

	CEA (*n*=53)	CAS (*n*=148)	*P*
Age	75.1±9.1	74.7±7.3	ns
M : F	47:6	136:12	ns
Symptomatic	44 (83%)	97 (65.5%)	0.017
Previous PCI	7 (13.2%)	17 (11.5%)	ns
Coronary CTA	43 (81.1%)	110 (74.3%)	ns
Silent CAD	14 (32.6%)*	46 (41.8%)*	ns
Preoperative PCI	2 (3.8%)	8 (5.4%)	ns
Preoperative consultation	4 (7.5%)	18 (12.2%)	ns
Postoperative consultation	5 (9.4%)	18 (12.2%)	ns
Postoperative PCI	4 (7.5%)	13 (8.8%)	ns

ns: Non-significant, CEA: Carotid endarterectomy, CAS: Carotid artery stenting, PCI: Percutaneous coronary intervention, CAD: Coronary artery disease, CTA: computed tomography angiography, *n*: Number, *: Percentage of silent CAD among those who underwent coronary CTA, M: Male, F: Female

Preoperative consultations regarding coronary CTA for coronary artery lesions were not performed in patients who had undergone previous examinations or PCI and were still attending the hospital. Preoperative consultation with a cardiologist was performed in four patients in the CEA group, all of whom had an abnormal CTA. In addition, 18 patients in the CAS group underwent preoperative consultation, of whom nine had abnormal coronary CTA. PCI was performed before carotid therapy in two cases in the CEA group (3.8% of all patients who had undergone CEA) and eight cases in the CAS group (5.4% of all patients who had undergone CAS). Postoperative consultation with a cardiologist was performed in five patients in the CEA group, of whom two had abnormalities on coronary CTA, and 18 patients in the CAS group, of whom 14 had abnormalities on CTA. Postoperative PCI was performed in four and 13 patients in the CEA and CAS groups, respectively. Perioperative complications, such as angina pectoris or myocardial infarction, were not observed.

Case 1: 70-year-old female

The patient was 70-year-old during PCI and 71-years-old during carotid artery treatment. She was first examined at our hospital after carotid ultrasonography when bilateral internal carotid artery stenosis was detected. Her peak systolic flow velocity was >400 cm/s bilaterally, and angiography was performed for carotid artery treatment despite no symptoms of stenosis [Figures 1a and b]. The patient was referred to a cardiologist at another hospital after coronary CTA showed multiple coronary artery stenoses [Figures 1c and d]. After examination and hospitalization, PCI was performed twice for stenoses of the right coronary artery [Figures 1e and f], left anterior descending branch, and circumflex branch. CEA was performed for a left internal carotid artery stenosis 2 months after the last PCI, and CAS was performed for a right internal carotid artery stenosis 3 months thereafter. The patient did not develop cerebral ischemia or thoracic symptoms and has been doing well.

Case 2: 73-year-old male

The patient was 73-year-old during carotid artery treatment and 75-year-old during PCI. He was diagnosed with symptomatic left internal carotid artery stenosis caused by amaurosis fugax. Carotid ultrasonography revealed low echogenicity; time-of-flight magnetic resonance

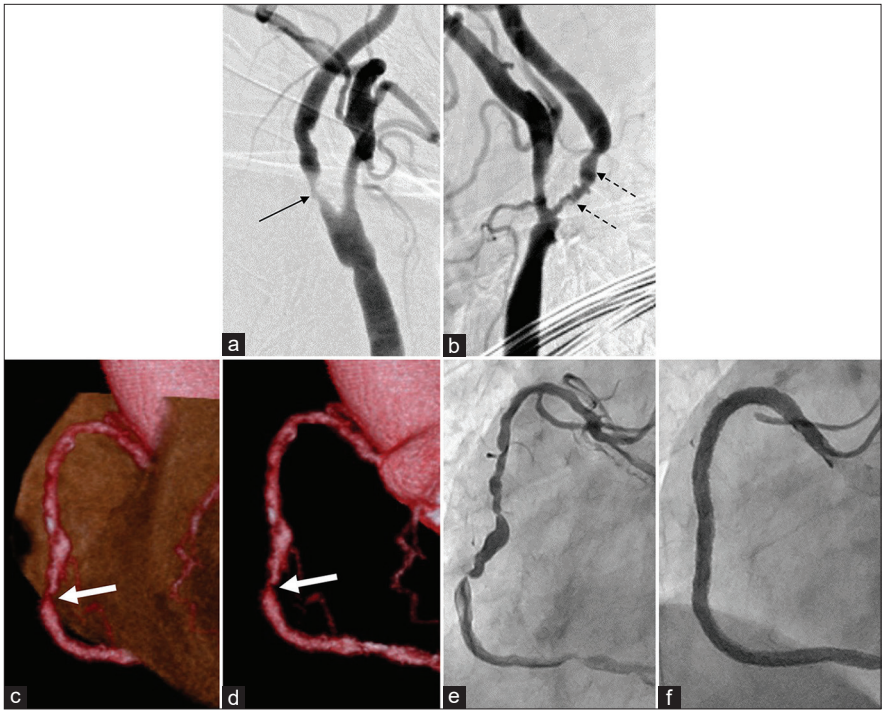

Figure 1: Case 1. Right carotid artery stenosis (arrow, a) and left carotid artery stenosis (dotted arrows, b). Right coronary artery severe stenosis (white arrow, c and d), followed by coronary artery angiography (e) showing irregular wall and severe stenosis reconstructed with stents (f).

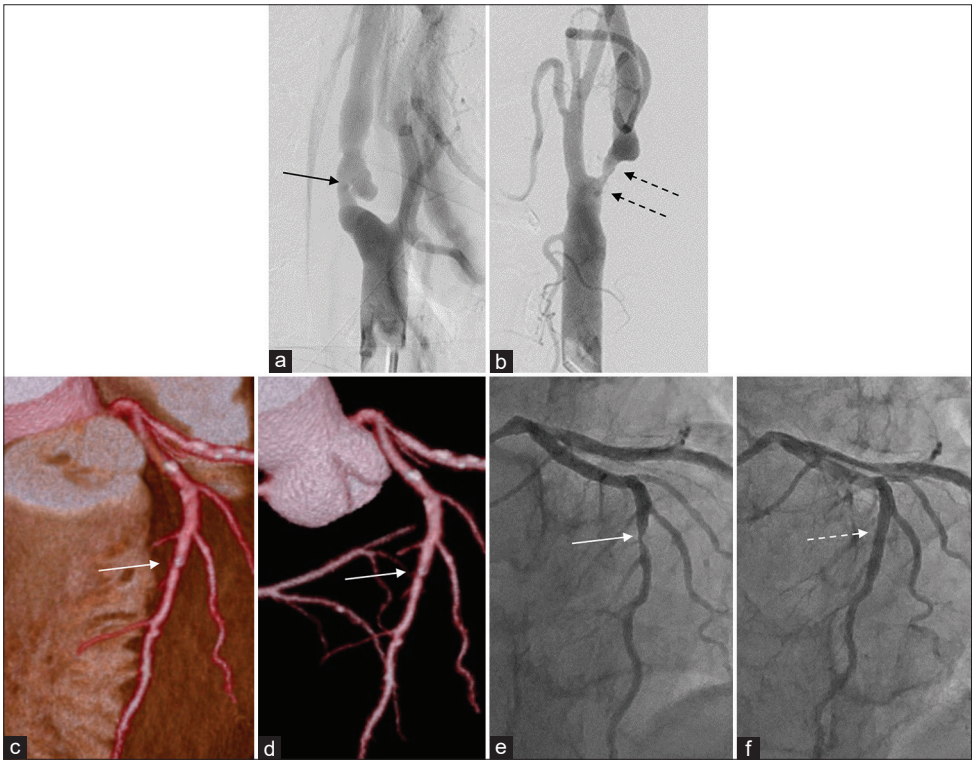

Figure 2: Case 2. Right carotid artery stenosis (arrow, a) and left carotid artery stenosis (dotted arrows, b). Left anterior descending artery mild calcification (white arrow, c and d) in preoperative examination before carotid artery treatment. After 1½ year, percutaneous coronary intervention was performed in the same artery (e: white arrow, f: white dotted arrow).

angiography revealed high-intensity plaque and angiography confirmed bilateral internal carotid artery stenosis [Figures 2a and b]. Coronary CTA revealed calcification in the anterior descending branch of the left coronary artery, although no severe stenosis was noted [Figures 2c and d]. First, CEA was performed for symptomatic left internal carotid artery stenosis. Although the right internal carotid artery stenosis was asymptomatic, it had severe stenosis with an irregularly shaped plaque, for which CAS was performed 1 month after CEA. The patient's postoperative course was good. However, one antiplatelet drug was continued. Approximately 1 year and 6 months after CAS, the patient was admitted to the cardiology department of a nearby hospital due to the emergence of chest symptoms. Emergency coronary angiography was performed and PCI was performed as an elective procedure for the left anterior descending coronary artery stenosis [Figures 2e and f]. The patient did not develop any further chest symptoms and has been doing well.

DISCUSSION

Regarding the possibility of complications and sequelae between cerebral infarction and CAD, reports have shown that approximately 15.8% of patients with atherothrombotic cerebral infarction had a history of CAD,[8] approximately 2.2% of patients annually developed myocardial infarction after a transient ischemic attack or stroke[16] and 9.2% of patients with transient ischemic attacks and cerebral infarctions without a history of CAD had a coronary event within 5 years.[1] The possible correlation between atherosclerotic changes in the carotid and coronary arteries has been long reported,[12,13] suggesting that atherosclerosis in the extracranial carotid arteries has a particularly close relationship with coronary artery lesions.[5] Atherosclerosis is more likely to be observed in the coronary arteries first, followed by stenosis in the carotid and peripheral arteries.[4,11] Atherosclerosis is a diffuse vascular disease and is similar to the atherosclerosis of the carotid and coronary arteries.[2] In line with this, a previous autopsy study recognized a histological association between carotid and coronary atherosclerosis.[10] Moreover, Mahmoudi *et al*.[9] revealed a strong correlation between CAD and carotid artery stenosis for CAS indication, with their data showing that among the 30% of patients with CAD scheduled for coronary artery bypass graft (CABG), >50% had carotid stenosis.[9] A report from Japan stated that among the 632 patients with suspected CAD who underwent coronary angiography, 433 (68.5%) had CAD and 124 (19.6%) had carotid artery stenosis.[15] The frequency of carotid stenosis increased with increasing coronary vascular variables.[15] Zhang *et al*. revealed that approximately 20% of patients with coronary multivessel disease had >50% carotid stenosis, indicating a direct correlation between the severity of carotid stenosis and the extent of coronary artery involvement.[17] Similarly, a Japanese report revealed that 19.4% of patients with three-vessel disease had >70% NASCET stenosis on angiography.[15] At our institution, we perform coronary CTA as a screening procedure for atherosclerotic carotid stenosis in patients who can tolerate CTA. Coronary CTA has high sensitivity and specificity for detecting CAD[6,14] and multidetector CT is a minimally invasive method to evaluate CAD. Table 2 compares the comorbidity of CAD in the treatment group for carotid artery stenosis with that reported in previous studies. A report on silent CAD in CEA cases by Krievins *et al*., which evaluated 90 CEA cases who underwent preoperative coronary CTA, revealed coronary artery stenosis in 25 cases (28%),[7] a value comparable to that observed in the present study (26.4%). In addition, they analyzed fractional flow reserve (FFR) through CT and revealed myocardial ischemia in 51 patients (57%). After CEA, coronary angiography was performed in 36 patients with these significant lesions, and 30 (33%) patients underwent PCI or CABG. These results were comparable to those of the present study in terms of stenotic lesion detection through CTA and absence of cardiac complications in the 1st year after the procedure, although 7.5% of our cases underwent PCI after the procedure. Another study examining silent CAD in 112 CAS cases who had undergone preoperative coronary angiography[3] revealed coronary artery stenosis of ≥75% in 39 patients (34.8%), which was comparable to that observed in the present study (31.1%). In addition, 16 patients (14.3%), of whom 11 had undergone PCI and five had undergone CABG, received coronary artery treatment after carotid

Table 2: Comparison between the current study and previous reports.

CEA		
	Current study (*n*=53) (%)	**Krievins (*n*=90) (%)**
Previous PCI	7 (13.2)	NA
Silent CAD	14 (36.4)	25 (28)
Preoperative PCI	2 (3.8)	NA
Postoperative PCI	4 (7.5)	30 (33)
CAS		
	Current study (*n*=148) (%)	**Enomoto (*n*=112) (%)**
Previous PCI	17 (11.5)	16 (14.3)
Silent CAD	46 (31.1)	39 (34.8)
Preoperative PCI	6 (4.1)	11 (9.8)
Postoperative PCI	13 (8.8)	16 (14.3)

CEA: Carotid endarterectomy, CAS: Carotid artery stenting, PCI: Percutaneous coronary intervention, CAD: Coronary artery disease, NA: Not available, *n*: Number

artery treatment due to abnormalities noted on preoperative coronary angiography, whereas at our institution, only 8.8% of the patients received the same (all underwent PCI).

Although CTA is inferior to coronary angiography in terms of its accuracy in assessing stenosis rate, it has comparable ability in detecting the presence of coronary stenotic lesions and myocardial complications during the 1st year after the procedure. Preoperative consultation results and PCI through coronary CTA may have prevented perioperative complications, such as angina pectoris and myocardial infarction, and postoperative consultation with the cardiologist included patients who had no significant abnormalities on preoperative CTA. This indicates the need for follow-up considering CAD even after treatment. The disadvantage of CTA lies in its difficulty in accurately assessing the stenosis rate due to calcification; as such, coronary angiography and FFR of CT exhibit better accuracy in assessing stenosis rate and ischemia. In our case, screening through CTA detected stenosis and ischemia at rates similar to those reported in the previous studies, which may lead to lower perioperative complications and improved long-term prognosis through pre and postoperative coronary artery treatment.

Limitations

The present study had some limitations. Given that not all patients received consultation from a cardiologist before surgery, treatment priorities may have been biased toward carotid artery treatment, although the study was retrospective in nature and the presence of coronary CTA was determined by the radiology department.

CONCLUSION

Screening may detect asymptomatic coronary artery lesions in carotid artery stenosis even in patients without chest symptoms and suspicion of ischemic heart disease. Preoperative coronary artery screening is important considering that pre and postoperative coronary artery treatment may improve long-term prognosis.

Declaration of patient consent

The authors certify that they have obtained all appropriate patient consent.

Financial support and sponsorship

Nil.

Conflicts of interest

There are no conflicts of interest.

REFERENCES

1. Amarenco P, Bogousslavsky J, Callahan A 3rd, Goldstein LB, Hennerici M, Rudolph AE, *et al*. High-dose atorvastatin after stroke or transient ischemic attack. N Engl J Med 2006;355:549-59.
2. Daly C, Rodriguez HE. Carotid artery occlusive disease. Surg Clin North Am 2013;93:813-32, viii.
3. Enomoto Y, Yoshimura S, Yamada K, Kawasaki M, Nishigaki K, Minatoguchi S, *et al*. Silent coronary artery disease in Japanese patients undergoing carotid artery stenting. J Stroke Cerebrovasc Dis 2013;22:1163-8.
4. Hertzer NR, Young JR, Beven EG, Graor RA, O'Hara PJ, Ruschhaupt WF, *et al*. Coronary angiography in 506 patients with extracranial cerebrovascular disease. Arch Intern Med 1985;145:849-52.
5. Heyden S, Heyman A, Goree JA. Nonembolic occlusion of the middle cerebral and carotid arteries-a comparison of predisposing factors. Stroke 1970;1:363-9.
6. Hoffmann U, Ferencik M, Cury RC, Pena AJ. Coronary CT angiography. J Nucl Med 2006;47:797-806.
7. Krievins D, Zellans E, Latkovskis G, Jegere S, Kumsars I, Kaufmanis K, *et al*. Diagnosis and management of silent coronary ischemia in patients undergoing carotid endarterectomy. J Vasc Surg 2021;73:533-41.
8. Leys D, Woimant F, Ferrieres J, Bauters C, Touboul PJ, Guerillot M, *et al*. Detection and management of associated atherothrombotic locations in patients with a recent atherothrombotic ischemic stroke: Results of the DETECT survey. Cerebrovasc Dis 2006;21:60-6.
9. Mahmoudi M, Hill PC, Xue Z, Torguson R, Ali G, Boyce SW, *et al*. Patients with severe asymptomatic carotid artery stenosis do not have a higher risk of stroke and mortality after coronary artery bypass surgery. Stroke 2011;42:2801-5.
10. Mitchell JR, Schwartz CJ. Relationship between arterial disease at different sites. A study of the aorta and coronary, carotid, and iliac arteries. Br Med J 1962;1:1293-301.
11. Sanguigni V, Gallu M, Strano A. Incidence of carotid artery atherosclerosis in patients with coronary artery disease. Angiology 1993;44:34-8.
12. Silverstein A, Hollin S. Internal carotid vs middle cerebral artery occlusions: Clinical differences. Arch Neurol 1965;12:468-71.
13. Solberg LA, McGarry PA, Moossy J, Strong JP, Tejada C, Löken AC. Severity of atherosclerosis in cerebral arteries, coronary arteries, and aortas. Ann N Y Acad Sci 1968;149:956-73.
14. Stein PD, Beemath A, Kayali F, Skaf E, Sanchez J, Olson RE. Multidetector computed tomography for the diagnosis of coronary artery disease: A systematic review. Am J Med 2006;119:203-16.
15. Tanimoto S, Ikari Y, Tanabe K, Yachi S, Nakajima H, Nakayama T, *et al*. Prevalence of carotid artery stenosis in patients with coronary artery disease in Japanese population. Stroke 2005;36:2094-8.
16. Touze E, Varenne O, Chatellier G, Peyrard S, Rothwell PM, Mas JL. Risk of myocardial infarction and vascular death after transient ischemic attack and ischemic stroke: A systematic review and meta-analysis. Stroke 2005;36:2748-55.

17. Zhang J, Xu R, Liu P, Fan X, Ye Z. Prevalence of carotid artery stenosis in Chinese patients with angina pectoris. J Thorac Dis 2015;7:2300-6.

How to cite this article: Uchida T, Kanazawa R, Higashida T, Watanabe S, Kono T. Importance of preoperative coronary artery examination before performing procedures for carotid artery stenosis. Surg Neurol Int 2023;14:229.