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Extracranial Carotid Stenting Cases Performed in an Outpatient Ambulatory Setting

Pui Man Rosalind Lai MD[1-4], Elad I Levy MD, MBA[1-5,*]

[1] *Department of Neurosurgery, Jacobs School of Medicine and Biomedical Sciences, University at Buffalo, Buffalo, New York, USA*

[2] *Department of Neurosurgery, Gates Vascular Institute at Kaleida Health, Buffalo, New York, USA*

[3] *Canon Stroke and Vascular Research Center, University at Buffalo, Buffalo, New York, USA*

[4] *Jacobs Institute, Buffalo, New York, USA*

[5] *Department of Radiology, Jacobs School of Medicine and Biomedical Sciences, University at Buffalo, Buffalo, New York, USA*

Abstract

Background and Objectives— Extracranial carotid artery stenting (CAS) has been shown to be safe and effective for asymptomatic and symptomatic high-grade stenosis. Although same-day discharge has been reported in hospital settings, CAS has not been performed in the outpatient ambulatory setting. The objective was to evaluate the feasibility and safety of performing CAS within an ambulatory center with same-day discharge.

Methods— We performed a retrospective review of our medical records to identify patients with asymptomatic carotid stenosis who underwent CAS at an ambulatory center with same-day discharge. Patients in whom the procedures were performed through a femoral approach under conscious sedation using the Neuroguard 3-in-1 stent system (Medtronic, Dublin, Ireland) or Wallstent (Boston Scientific, Marlborough, MA, USA) with a balloon guide catheter for proximal protection were included.

Results— Four patients with favorable vascular anatomy were carefully selected for treatment of asymptomatic carotid artery stenosis and underwent outpatient CAS between October 14, 2025 and May 15, 2026. The mean age was 73±6 years. There were no periprocedural complications, and all patients had uneventful follow up without evidence of stroke, transient ischemic attack, or access-site complications. All procedures were completed within 60 minutes (mean and standard deviation, 36±20 minutes).

Conclusions— These cases demonstrate the feasibility of performing CAS entirely in the outpatient setting in carefully selected patients. Outpatient CAS may offer an alternative to the traditional hospital, while maintaining patient safety.

Keywords— ambulatory, carotid artery stenting, outpatient.

Abbreviations— BGC, balloon guide catheter; CAS, carotid artery stenting; cm/s, centimeters per second; CTA, computed tomography angiography; DWI, diffusion-weighted imaging; IV, intravenous; mg, milligram; MRI, magnetic resonance imaging.

BACKGROUND

There has been a major shift of surgical procedures to the outpatient setting, thereby improving both cost efficiency and patient satisfaction.[1] Although specialties such as orthopedics, general surgery, and plastic surgery have rapidly adopted this model for low-complexity procedures,[2,3] neurosurgery has been slower to do so because of the higher complexity and perceived risk of neurosurgical cases.[4,5] However, with careful patient selection and advances in neuroendovascular technology, certain endovascular procedures can be safely performed in the ambulatory setting. We have previously published experiences with outpatient diagnostic cerebral angiography and flow-diverting stent embolization for cerebral aneurysms.[6,7] To our knowledge, however, outpatient carotid artery stenting (CAS) has not yet been described in the literature.

CAS has become a well-established, safe, and feasible alternative to carotid endarterectomy for both symptomatic and asymptomatic carotid stenoses. Since Medicare's 2023 expansion of CAS eligibility to include patients with symptomatic carotid stenosis ≥50% and asymptomatic stenosis ≥70%, more patients have become eligible for this treatment. In the post-COVID era, increasing efforts have

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*Corresponding Author: Elad I. Levy MD MBA, University at Buffalo Neurosurgery, 100 High Street, Suite B4, Buffalo, NY 14203 USA, Email: elevy@ubns.com Tel: 716-218-1000.

been made to transition to outpatient care.[8-10] Although same-day discharges after CAS have been reported in the hospital setting, performing CAS in a fully ambulatory environment has not previously been reported.[11]

We present the first four cases of CAS performed at an ambulatory neurosurgery center, with all patients discharged the same day and without complications. We describe our criteria for patient selection, procedural management, and short-term outcomes. These cases highlight the feasibility of performing CAS in an ambulatory setting with careful patient selection and a structured perioperative protocol.

METHODS

Institutional review board approval (Western IRB 45965973) was obtained, and the board waived the requirement for consent for inclusion in this retrospective case series. Procedural consent was obtained from each patient for the procedure prior to intervention. Patients were given the option to have the procedure performed at the ambulatory neurosurgery center or the hospital. The Preferred Reporting of Case Series (PROCESS) guidelines were followed. Data supporting the findings of this study are available from the corresponding author on reasonable request.

Four cases of CAS were performed between October 14, 2025 and May 15, 2026. Patients underwent screening and were deemed eligible by the attending neurosurgeon based on the ambulatory protocol (Text box). Baseline demographic and clinical characteristics, procedural details, perioperative outcomes, and follow-up data were collected through retrospective chart review.

All procedures were performed via a transfemoral approach using an 8-French (F) Walrus balloon guide catheter (Q'Apel Medical Inc., Fremont, CA, USA) for proximal flow arrest and additional embolic protection. Three patients underwent CAS using the Neuroguard 9-7-8-40 stent system (Medtronic, Dublin, Ireland), and one patient underwent stenting with an 8mm × 21mm Wallstent (Boston Scientific, Marlborough, MA, USA) (Table 1). Stent sizing and type were selected at the neurosurgeon's discretion.

Illustrative Case Presentation

A patient in his 70s, with a medical history remarkable for atrial fibrillation, hypertension, and hyperlipidemia, initially presented to the hospital with a symptomatic left carotid artery. At the time of stroke investigation, he was found to have severe contralateral asymptomatic carotid stenosis. Also, magnetic resonance diffusion-weighted sequencing demonstrated a punctate left ischemic signal change (Figure 1A). Due to the symptomatic nature of the left carotid artery, this symptomatic side was stented in the hospital, and the patient had an uneventful hospital course and was discharged on 81 mg of aspirin and 75 mg of clopidogrel daily. Three months after the initial infarct and stenting of the contralateral symptomatic carotid artery, the patient had made a complete recovery and underwent evaluation of the asymptomatic side. Computed tomography angiography (CTA) was notable for >80% stenosis of the right carotid artery (Figure 1B), and Doppler ultrasound of the right carotid artery demonstrated velocity of 290 cm/s over 67.9 cm/s. After extensive discussion with a neurologist, the patient agreed to proceed with right CAS.

The patient's CT angiogram was reviewed, and his aortic and carotid anatomy were deemed eligible for the Neuroguard IEP 3-in-1 Carotid Stent and Post-Dilatation Balloon System with Integrated Embolic Protection (Neuroguard IEP System; Medtronic, Dublin, Ireland) and for the procedure to be performed at the ambulatory center. He underwent medical clearance with his primary care physician. He was admitted, and the procedure was performed under conscious sedation using 2mg of midazolam and 50ug of fentanyl. A right femoral approach was performed with an 8F Pinnacle access sheath (Terumo Neuro, Aliso Viejo, CA, USA). After confirmation of access, intravenous heparin was infused to confirm the therapeutic activated clotting time, and glycopyrrolate was administered. Diagnostic angiography confirmed the severity of the right carotid artery stenosis (Figure 2A and 2B). An 8F Walrus balloon guide catheter was used for support; and with the balloon inflated for proximal protection control, a Hi-Torque Spartacore guidewire (Abbott Cardiovascular, Plymouth, MN, USA) was navigated across the stenotic segment and into the petrous segment of the carotid artery. The Neuroguard IEP System stent measuring 9-7-8 (unconstrained diameters: proximal end–midstent–distal end) × 40mm (length) was guided to the stenotic segment (Figure 2C and 2D). The filter component of the system was inflated, followed by stent placement and angioplasty balloon inflation. Final angiography showed patent stent filling (Figure 2E and 2F). The patient was transferred to the recovery unit. Three hours later, he was discharged from the ambulatory facility and transferred to a rehabilitation facility for overnight observation, as this was the first outpatient case performed at this ambulatory neurosurgical center. He returned to the clinic at his 2-week postoperative follow-up visit with no concerns.

Results

Four patients underwent CAS at the ambulatory neurosurgical center during the study period. The mean patient age was 73±6 years with equal representation of women and men. No patients had remarkable medical comorbidities. Three patients presented with asymptomatic carotid artery stenosis identified on routine screening. One patient presented with symptomatic contralateral carotid artery stenosis (Table 1).

The mean procedure duration was 36±20 minutes. Technical success was achieved in all four cases without conversion to inpatient admission or the need for additional intervention. All patients were discharged from the outpatient center within 7 hours of the procedure. There were no perioperative complications, such as stroke, transient ischemic attack, access-site complications, or in-stent restenosis. At the 2-week follow up, all patients remained neurologically intact without evidence of procedure-related complications.

Discussion

We present four cases of CAS performed in an ambulatory center, with all patients discharged on the same day within

Ambulatory Protocol for Carotid Artery Stenting at an Ambulatory Neurosurgery Center

Patient Selection (Preprocedural)

Clinical:

- Asymptomatic carotid lesion
- No high-grade cardiac disease or systemic comorbidities

Anatomical:

- Review of CTA of the aortic arch, common carotid artery, and internal carotid artery
- Not eligible if there is severe arch tortuosity, tonsillar loop, or marked carotid angulation

Discussion:

- Risks and benefits of ambulatory versus inpatient setting discussed with patient and family or authorized representative
- Medical clearance

Procedural (Day of)

- Confirm dual antiplatelet therapy with documented P2Y12 response
- Heparin administration after confirmation of access with confirmed therapeutic ACT prior to stent deployment
- Administer glycopyrrolate (omit if bradycardic)
- Continuous hemodynamic and neurologic monitoring throughout the procedure and recovery period

Same-Day Discharge Criteria

- Neurological examination remains unchanged from baseline
- Access-site hemostasis without complication
- Hemodynamic stable for >6 hours post procedure

Follow up

- Postoperative day 1 phone call and in-person clinic follow-up visit at 2 weeks postoperative

Abbreviations: ACT, activated clotting time; CTA, computed tomography angiography; P2Y12, purinergic receptor (P2) type Y (G protein-coupled), subtype 12.

TABLE 1: Baseline clinical characteristics, procedural details, and follow-up outcomes of 4 patients who underwent outpatient carotid artery stenting at an ambulatory neurosurgery center.

Patient	Age	Sex	Past medical history	Presentation	Access	Stent System	Procedural Duration (min.)
1 (Illustrative case)	77	M	Hypertension, hyperlipidemia, atrial fibrillation	Contralateral symptomatic carotid	8F femoral	Neuroguard 9-7-8-40	25
2	74	M	Coronary artery disease	Incidental, screening	8F femoral	Neuroguard 9-7-8-40	60
3	78	W	Remote ruptured basilar artery aneurysm s/p coiling	Incidental, screening	8F femoral	Wallstent 8mm × 21mm	15
4	64	W	Hypertension, hyperlipidemia, diabetes mellitus type 2	Incidental, screening	8F femoral	Neuroguard 9-7-8-40	45

Abbreviations: F, French; M, man; min., minutes; s/p, status post; W, woman.

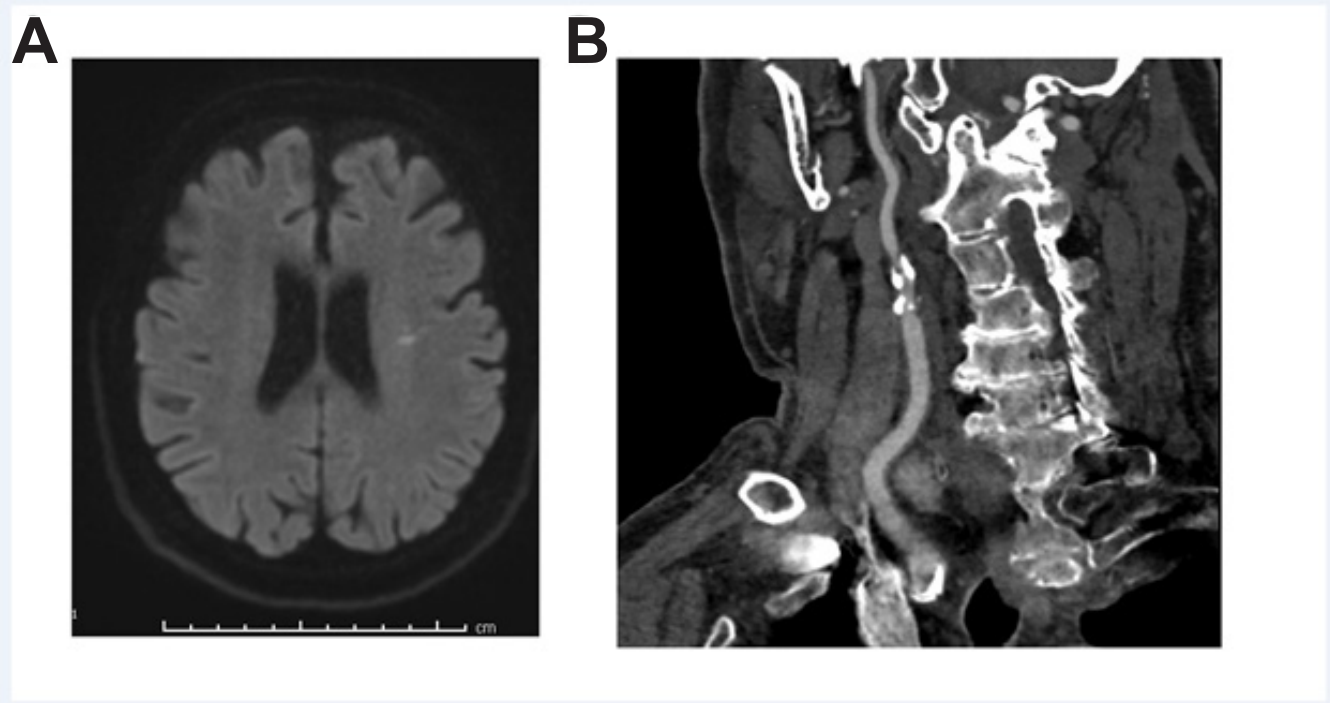


FIGURE 1: Magnetic resonance diffusion-weighted imaging in patient 1 demonstrating a punctate left ischemic change suggestive of symptomatic left carotid artery stenosis. The patient underwent left carotid artery stenting in the hospital and returned 3 months later for outpatient stenting of an asymptomatic right carotid artery (A). Computed tomography angiography (oblique view) of the right carotid artery in patient 1 demonstrating a severely calcific carotid artery stenosis. Note the relatively straight anatomy, which is favorable for treatment in an ambulatory setting (B).

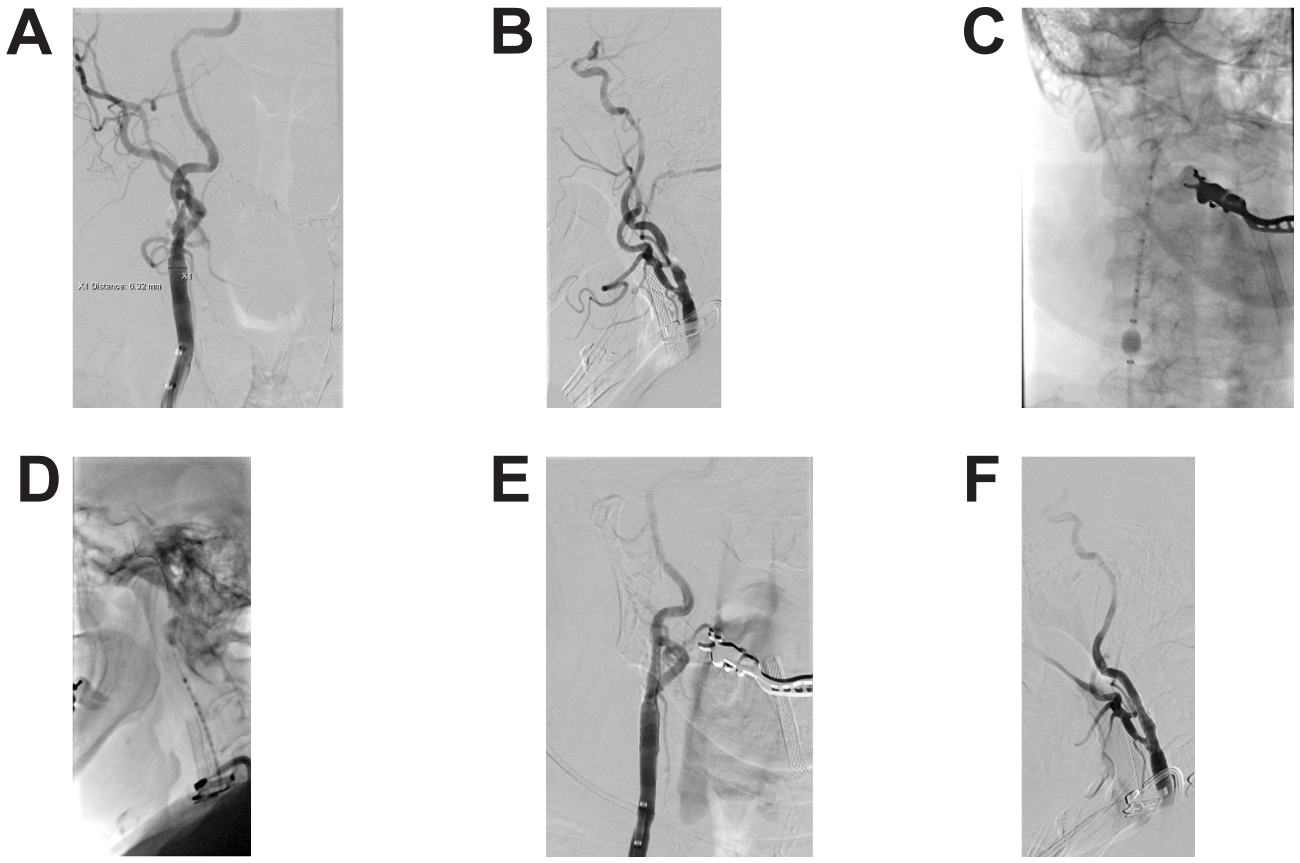


FIGURE 2: Right carotid artery stenting using the Neuroguard IEP System (Medtronic) in patient 1 at the ambulatory center. Digital subtraction angiography in the anteroposterior (A) and lateral (B) projections confirmed a severely stenotic right carotid artery with relatively straight anatomy. Anteroposterior (C) and lateral (D) radiographs during the deployment of the carotid stent. Final angiography was performed in the anteroposterior (E) and lateral (F) views confirming adequate placement of the carotid stent.

7 hours of the procedure and without complications. Each patient remained neurologically intact at the 2-week postprocedural follow up.

The concept of performing CAS in an outpatient environment is not entirely new. It was first proposed in the early 2000s, when CAS was primarily reserved for high-risk patients who were poor candidates for carotid endarterectomy.[12] After these early CAS procedures, patients were typically observed for 24 to 48 hours, often initially in the intensive care units. Increasingly, the protocol has shifted toward shorter observation periods, with most patients now observed overnight in the general ward. Advances in endovascular techniques, increased operator experience, shorter procedural time, and the use of conscious sedation instead of general anesthesia have collectively reduced the risk profile and need for long-term monitoring in CAS cases. Tan et al.[13] reviewed 208 consecutive CAS procedures over a 3-year period and found that the primary postoperative concern was transient hemodynamic instability, particularly hypotension. Subsequent reports have similarly demonstrated the safety of same-day hospital discharge after CAS, including one case where combined stenting of the carotid and coronary arteries was performed.[11] Although transient hypotension is a common event during balloon inflation for angioplasty, sustained hemodynamic instability following CAS is rare.

The COVID-19 pandemic disrupted but also accelerated changes in healthcare delivery through rapid adoption of same-day discharge protocols for several endovascular procedures, including middle meningeal artery embolization and CAS.[9,14] Kiwan et al.[9] reported a series of 45 consecutive CAS procedures with same-day discharge, demonstrating the safety and effectiveness of this approach. Safety remains paramount; and regardless of whether CAS is performed in a hospital or ambulatory center, there must be clear and standardized safety guidelines in place, including defined criteria for patient selection, intra- and post-procedural monitoring, and immediate transfer to a hospital if any clinical concerns arise. In our practice, there is an established protocol if a patient continues to have sustained hypotension, or other adverse clinical sequela, with a low threshold for transferring patients for hospital admission to exclude other etiologies or complications.

The key to successful ambulatory CAS is patient selection and establishing a clear protocol. We intentionally select patients with asymptomatic stenosis and minimal comorbidities, as these individuals are at lowest risk for periprocedural complications. Prior studies have found low stroke and mortality rates for CAS in the asymptomatic population.[15] Equally important is the choice of anesthesia. Conscious sedation has been demonstrated to be safe and effective for endovascular procedures including CAS and was used in the presented cases to reduce risks associated with general anesthesia.[16] Another major component to the success of outpatient CAS is comprehensive preprocedural counseling, where patients are informed of the risks and benefits of receiving CAS in an ambulatory center vs a hospital setting. Only patients who met the medical and radiographic criteria were offered the outpatient option, with the hospital also remaining as an available option. This shared decision-making approach ensured that the patient was comfortable and confident in the chosen setting.

The selection of patients with favorable vascular anatomy is equally critical for successful CAS in the ambulatory setting. In our cases, preprocedural CTA was reviewed carefully, starting with the evaluation of the aortic arch to ensure straightforward access to the common carotid artery. Elderly patients often have severe vascular tortuosity, which may make catheter navigation more challenging and require more complex choices of catheters, thus being less suitable for the outpatient setting.

In all presented cases, the common and internal carotid arteries were relatively straight, without severe angulation, tortuosity, or the presence of a tonsillar loop. This favorable anatomy allowed for smooth passage of the guidewire across the stenotic segment and easy guidance of the stent through the stenotic segment. The degree and morphology of the stenosis are also important considerations. Near-occlusive or totally occluded lesions often require microcatheter or microwire techniques, which are not suitable for the ambulatory setting. In contrast, the cases presented involved short, focal stenoses that were less complex for the neurosurgeon to navigate with the wire and stent. Such anatomical simplicity is the key to reducing procedural time and risk in the outpatient setting.

Another key factor in safely performing endovascular procedures in the ambulatory center is the advancement of device technology, which significantly improved procedural safety profiles. Similar to how innovations in flow-diverting stents have allowed for outpatient transition, the development of novel CAS systems has simplified device navigation and reduced procedural risk. The use of second-generation stents is associated with reduced ipsilateral stroke and restenosis when compared to first-generation stents.[17] In three of the four cases, we utilized the second-generation Neuroguard IEP System. This 3-in-1 device combines a premounted balloon with the stent and a 40 micron filter within a single system. This “all-in-one” design eliminates the need for multiple device exchanges, reducing the risk of losing the wire or wire-related vessel injury. This device has been demonstrated to have strong safety profile.[18] The use of the Walrus balloon guide catheter also provided proximal flow control, thereby reducing antegrade flow during angioplasty and stenting and minimizing the risk of distal embolization. In situations where intra-procedural hypertension occurs, the balloon can also be used for brief flow arrest until the blood pressure stabilizes using intraarterial medications, further reducing the risk of hyperperfusion injury.

Equally important to the success of the procedure is the postprocedural care. As in the inpatient setting, patients at the ambulatory center are closely monitored for cardiac and hemodynamic changes following CAS. Given that only asymptomatic patients are selected, postprocedure monitoring includes continuous electrocardiography, serial neurologic examinations, and vascular access-site assessment. Within

7 hours of observation, all 4 patients were deemed stable to be discharged from the ambulatory center. Each patient was contacted 1 day after the procedure to assess for any delayed symptoms or concerns, and returned for their 2-week follow-up visits without complications. All patients reported an overall positive experience.

Conclusions

These four cases demonstrate that CAS can be performed safely in the ambulatory setting in carefully selected patients. Major factors for success included rigorous patient selection, favorable vascular anatomy, the use of an advanced stent system (in most cases), and structured preprocedure and postprocedure protocols. Outpatient CAS may offer a safe and efficient alternative to the traditional inpatient management, reducing hospitalization while maintaining a high standard of care.

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