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Original Article

Evaluating Endovascular Strategies for Carotid Blowout Syndrome: A Retrospective Analysis at a Single Institution

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Abstract

Background Carotid blowout syndrome (CBS) is a life-threatening complication predominantly associated with head and neck malignancies. The high morbidity and mortality rates necessitate effective management strategies. This study evaluates the efficacy and safety of endovascular interventions in managing CBS.

Methods We conducted a retrospective analysis of endovascular treatments for CBS performed at our institution from 2016 to 2023. Data on patient demographics, cancer types, previous treatments, and specific CBS characteristics were collected. Outcomes measured included procedural success, posttreatment complications, and mortality rates.

Results The study included 19 patients with a mean age of 56.7 ± 11.15 years, predominantly male. Lesion locations included internal carotid arteries (ICAs) (42.1%), common carotid arteries (36.8%), and external carotid arteries (21.1%). CBS presentations were classified as threatened (26.3%), impending (42.1%), and acute (31.6%). Endovascular procedures included coil occlusion with Micro Vascular Plug (MVP) systems (31.6%), standalone coil occlusion (21.1%), covered stent placement (15.8%), polyvinyl alcohol embolization particles (15.8%), standalone MVP occlusion (10.5%), and MVP occlusion with a flow diverter and covered stent (5.3%). Technical success was achieved in all cases. Intraoperative rerupture occurred in one patient. Postprocedural complications included stroke (10.5%), rebleeding (10.5%), infection (10.5%), and carotid sinus syndrome (5.3%). The mortality rate before discharge was 21.1%, primarily due to cancer-related causes. Importantly, one of the deaths was procedure-related, occurring as a result of a stroke following thrombosis at the repair site.

Conclusion Endovascular treatments for CBS offer promising outcomes, characterized by high technical success, and provide viable alternatives to traditional surgical interventions. While these minimally invasive techniques effectively control

Keywords
- carotid blowout syndrome
- endovascular interventions
- flow diverter devices
- head and neck oncology

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hemorrhage, it is important to consider the associated complication rates, which necessitate careful patient selection and thorough procedural planning. Despite the challenges posed by the advanced nature of underlying malignancies, the adoption of a multidisciplinary approach is critical to optimize outcomes in CBS management.

Introduction

Carotid blowout syndrome (CBS) is a life-threatening condition usually seen in patients with head and neck malignancies, resulting from an acute hemorrhage from the carotid artery or its branches. It is specifically linked with high rates of morbidity and mortality due to the critical nature of the carotid artery in blood supply to the brain.[1–3] Effective management of CBS often requires a multidisciplinary approach, integrating endovascular, surgical, and oncological expertise to modify the treatment to suit the condition and the underlying pathology in an individual patient.[1] Treatment options for CBS have evolved significantly, with a current emphasis on minimally invasive endovascular techniques.

Methods

We conducted a retrospective analysis of our neurovascular database and identified 19 consecutive endovascular treatments for CBS from 2016 to 2023 at our single institution. Data was collected on patient demographics, cancer types, prior cancer treatments, CBS type, diagnostic procedures, endovascular interventions, and outcomes, including complications. All patients (or their substitute decision-makers) consented to the treatment after a comprehensive discussion of the available treatment options. Our institutional review board approved the study design with a waiver of informed consent due to its retrospective nature.

We defined the type of CBS according to the classification by Chaloupka et al.[4] Threatened CBS was identified when there was no evidence of acute hemorrhage. Impending CBS was characterized by short, episodic hemorrhages through a surgical wound or fistula, associated with a pseudoaneurysm that bleeds intermittently. Acute CBS was defined as the complete rupture of the carotid arteries, resulting in a nonself-limiting hemorrhage.

Mean, median, standard deviation, and minimum and maximum values were used as descriptive statistics for numerical data whereas number and percentages were used for categorical data.

Decision-Making Process

Our decision-making process integrated multiple factors, including the morphology, dimensions, and location of vascular involvement, extent of erosion, and the presence of underlying malignancies. Balloon occlusion tests (BTOs) were performed in nonemergent cases to assess the feasibility of vessel sacrifice. For lesions involving only the external carotid artery (ECA), a BTO was not necessary, given the minimal risk of brain ischemia.

We employed the GORE VIABAHN VBX Balloon Expandable Endoprosthesis for stent grafts to adapt to the unique requirements of carotid artery reconstruction, given the absence of stent grafts specifically designed for the carotid artery. While covered stent grafts are often preferred for managing long lesions due to their ability to reconstruct the vessel wall, their application in patients with head–neck cancers was limited. The unstable neovascularization associated with these tumors and the required antiplatelet therapy posed a high risk of exacerbating tumor-related bleeding. Consequently, in cases requiring deconstructive occlusion of the internal carotid artery (ICA), deconstructive occlusion of the common carotid artery (CCA) was favored. This approach leveraged the formation of collateral branches from the ECA, facilitating retrograde flow into the ICA and preserving cerebral perfusion.

In instances of ECA involvement, coil occlusion was the preferred treatment due to the lower risk associated with deconstructing ECA branches. Polyvinyl alcohol (PVA) embolization particles were selectively used for targeting the ECA branches supplying the tumor, ensuring precise embolization while minimizing collateral damage. To mitigate the risks of partial thrombosis and potential stroke, Micro Vascular Plug (MVP) systems were employed prior to coil occlusion, enhancing the safety and efficacy of the procedure by securing the vessel closure without leaving residual flow.

Posttreatment, patients received aspirin as a standard antiplatelet measure to prevent thrombotic complications, particularly suitable for those who underwent coil occlusion, plugs, or PVA embolization. Conversely, all patients who received covered stents or flow diverters were administered dual-antiplatelet therapy, reflecting the higher thrombogenic risk associated with these devices. In some cases, the antiplatelet regimen was modified or not administered due to the acute nature of the hemorrhage, especially in emergencies where rapid control of bleeding was prioritized, or in scenarios involving only PVA occlusion of small feeding vessels where the risk of thrombosis is minimal.

Follow-up angiograms were conducted only if there was evidence of recurrent CBS or new neurological symptoms associated with the procedure.

Results

Patient and CBS Characteristics

The study included 19 patients, predominantly male, with a mean age of 56.7 ± 11.15 years (range 22–71 years,

►**Table 1**). Patient diagnoses included: tonsillar cancer (21.1%), hypopharyngeal cancer (21.1%), laryngeal cancer (15.8%), thyroid cancer (15.8%), stab wounds to the neck (10.5%), tongue-base cancer (5.3%), osteosarcoma of the mandible (5.3%), and idiopathic CBS (5.3%).

Lesions occurred in the ICAs in 42.1% of cases, CCAs in 36.8% of cases, and ECAs in 21.1% of cases. CBS presentations included threatened (26.3%), impending (42.1%), and acute (31.6%). Common clinical symptoms were hemoptysis or hematemesis (52.6%), intraoperative rupture or neck drain bleeding (10.5%), and traumatic stab wounds (10.5%). A history of recurrent hemorrhages was noted in 36.8% of patients.

Most patients had undergone previous cancer treatments, with 21.1% receiving radiation therapy, 10.5% surgical treatments, and 42.1% both. Five patients (26.3%) had not received prior cancer treatments.

Patient and lesion characteristics are summarized in ►**Table 1**.

Table 1 Patient and CBS characteristics

Characteristic	Value
No. of patients	19
Mean age in years (± SD)	56.7 ± 11.15
Female gender, no. (%)	5 (26.3)
Lesion type, no. (%)	
Tonsillar cancer	4 (21.1)
Hypopharynx cancer	4 (21.1)
Laryngeal cancer	3 (15.8)
Thyroid cancer	3 (15.8)
Stab wound to neck	2 (10.5)
Tongue base cancer	1 (5.3)
Osteosarcoma of the mandible	1 (5.3)
Idiopathic	1 (5.3)
Previous cancer treatments, no. (%)	
Radiation therapy	4 (21.1)
Surgical treatment	2 (10.5)
Radiation and surgery	8 (42.1)
None	5 (26.3)
Lesion location, no. (%)	
Common carotid artery	7 (36.8)
Internal carotid artery	8 (42.1)
External carotid artery	4 (21.1)
CBS type, no. (%)	
Threatened	5 (26.3)
Impending	8 (42.1)
Acute	6 (31.6)
Clinical presentation, no. (%)	
Hemoptysis or hematemesis	10 (52.6)
Intraoperative rupture or bleeding from neck drains	2 (10.5)
Trauma (stab wound)	2 (10.5)
Other[a]	5 (26.3)
Positive history of recurrent hemorrhages, no. (%)	7 (36.8)

Abbreviations: CBS, carotid blowout syndrome; CT, computed tomography; PET, positron emission tomography; SD, standard deviation.
[a]Other clinical presentations included: multiple syncopal episodes and tremors (1); cranial neuropathy and ischemic stroke (1); abnormal restaging CT and PET scan findings (1); epistaxis (1); throat swelling, difficulty breathing (1).

Procedural Data Analysis

Median timing for endovascular procedures postradiation therapy was 225 days (range 7–1,116 days), and postsurgery was 511 days (range 16–5,116 days, ►**Table 2**). Diagnostic subtraction angiography (DSA) revealed pseudoaneurysms with wall irregularity in 63.2% of patients, extravasation in

Table 2 Treatment and outcomes characteristics

Characteristic	Value
Median timing for the endovascular procedure	225 days after previous radiotherapy; 511 days after previous surgery
DSA findings at the moment of the procedure, no. (%)	
Pseudoaneurysm with wall irregularity	12 (63.2)
Extravasation	2 (10.5)
Pseudoaneurysm with extravasation	1 (5.3)
None	4 (21.1)
Procedure type, no. (%)	
Standalone coil occlusion	4 (21.1)
Standalone Micro Vascular Plug system	2 (10.5)
Coil occlusion + Micro Vascular Plug system	6 (31.6)
Covered stent/stent-graft	3 (15.8)
Polyvinyl alcohol embolization particles	3 (15.8)
Flow diverter + covered stent + Micro Vascular Plug system	1 (5.3)
Occlusion site (for coil occlusion), no. (valid %)	
Common carotid artery total occlusion	5 (41.7)
Internal carotid artery total occlusion	3 (25)
External carotid artery total occlusion	2 (16.7)
External carotid artery branch occlusion	1 (8.3)
Thyrocervical branch of subclavian artery	1 (8.3)

(*Continued*)

Table 2 (*Continued*)

Characteristic	Value
Intraprocedural complications, no. (%)	
Intraoperative rerupture	1 (5.3)
None	18 (94.7)
Intraprocedural intravenous antiplatelets, no. (%)	
Cangrelor	3 (15.8)
Eptifibatide	1 (5.3)
None	15 (78.9)
Posttreatment antiplatelet therapy, no. (%)	
Dual-antiplatelet therapy	4 (21.1)
Aspirin only	13 (68.4)
None	2 (10.5)
Posttreatment complications, no. (%)	
Stroke	2 (10.5)
Rebleeding	2 (10.5)
Infection	2 (10.5)
Carotid sinus syndrome	1 (5.3)
None	12 (63.2)
Outcome, no. (%)	
Discharged	15 (78.9)
Death before discharge	4 (21.1)

Abbreviation: DSA, diagnostic subtraction angiography.

10.5%, and both in one patient. BTO was performed in three cases, and all three patients successfully passed the test. Notably, there were no evident DSA findings in 21.1% of patients. Intraprocedural intravenous antiplatelets were administered to patients that underwent stent deployment if they were not on dual-antiplatelet therapy prior to the procedure.

The types of procedures included coil occlusion with MVP systems (31.6%), standalone coil occlusion (21.1%), covered stent placement (15.8%), PVA embolization particles (15.8%), standalone MVP occlusion (10.5%), and MVP occlusion with flow diverter and covered stent in one case (5.3%). This latter combination was employed in a patient with tonsillar cancer and impending hemorrhage, featuring right ICA stenosis and right ECA focal narrowing suspected to be from adjacent tumor erosion or radiation necrosis. In this case, coils and an MVP were used to achieve total occlusion of the right ECA and the internal maxillary artery, while a flow diverter was placed in the cervical right ICA to maintain artery patency and ensure cerebral perfusion.

There was no mortality due to intraprocedural complications. One patient had intraoperative rerupture, while the other 18 patients (94.7%) had no intraprocedural complications. Technical success of the procedure was achieved in 100% of cases. Two illustrative clinical cases are demonstrated in ►**Fig. 1** and ►**Fig. 2**.

Postprocedural Complications and Clinical Outcomes

Posttreatment, 68.4% of patients received aspirin, 21.1% dual-antiplatelet therapy, and 10.5% none. Complications included stroke, rebleeding, and infection, each affecting 10.5% of patients. On average, rebleeding occurred 1.5 days postprocedure, while strokes occurred at an average of 3.5 days postprocedure. One patient developed carotid sinus syndrome. The mortality rate before discharge was 21.1%, primarily due to cancer-related causes. However, one death was attributed to a procedure-related complication. This case involved a patient with a CCA bifurcation injury resulting from a stab wound to the neck. DSA revealed a pseudoaneurysm with wall irregularity. The patient underwent coil occlusion of the thyrocervical branch of the subclavian artery. Postprocedure, the patient was maintained on aspirin therapy. Subsequently, thrombosis developed at the repair site, leading to a middle cerebral artery thrombus. This progression resulted in a severe decline in neurological

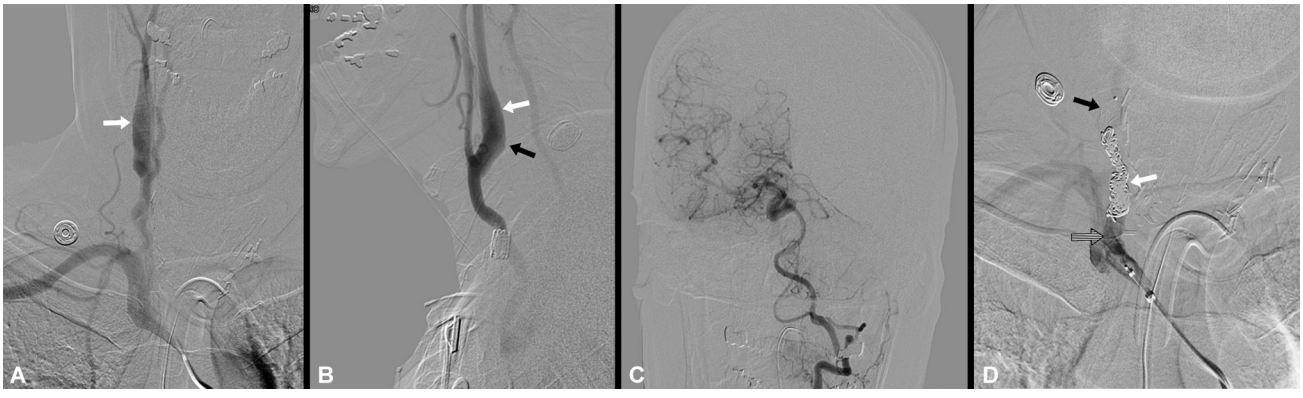

Fig. 1 A 60-year-old patient with metastatic thyroid cancer, who had previously undergone radiotherapy, thyroidectomy, and tracheal resection, was admitted with hemoptysis and frank tracheal bleeding. Angiograms of the right common carotid artery (CCA) in frontal (**A**) and lateral (**B**) views revealed a focal pseudoaneurysm (indicated by white arrows) and vessel wall irregularities (indicated by *a black arrow*), consistent with a contained carotid blowout. Angiograms of the left internal carotid artery and left vertebral artery (**C**) demonstrated excellent collateral circulation across the right posterior communicating artery. The patient underwent treatment (**D**) that involved occlusion of the right CCA with coils (*white arrow*), deployment of a 9-mm Micro Vascular Plug (MVP) within the distal right CCA (*black arrow*), and placement of an Amplatzer plug in the proximal right CCA (*striped arrow*). The patient passed away 81 days after discharge due to cancer-related complications.

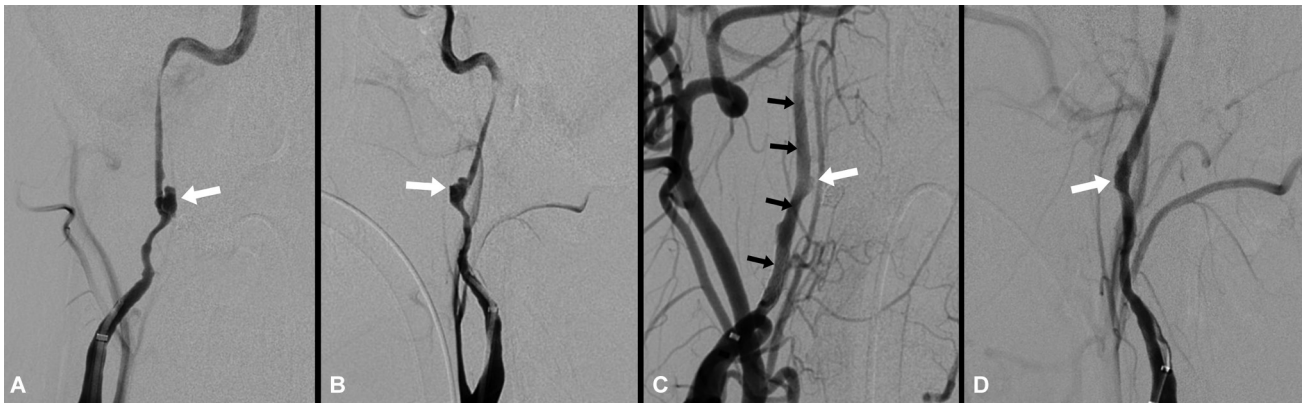

Fig. 2 A 46-year-old patient presented with an acute dissection of the right internal carotid artery (ICA) and a 12 × 8 mm dissecting pseudoaneurysm (**A**, **B**, indicated by *white arrows*). The Surpass Evolve flow diverter (indicated by *black arrows*) was employed to treat the pseudoaneurysm. Subsequent imaging (**C**, **D**) showed decreased flow within the previously observed pseudoaneurysm.

status and ultimately brain herniation, contributing to the patient's demise.

During the follow-up, one patient required additional treatment (PVA embolization) for recurrent rapidly expanding osteosarcoma with recurrent ulcerated hemorrhage. Follow-up indicated that 60% of discharged patients later died, with 53.3% due to cancer and 6.7% due to septic shock. In our study, the observed average survival was approximately 4.13 ± 3.33 months, with a median survival of 4.17 months.

Detailed procedural and outcome data are provided in ►**Table 2**.

Discussion

Risk factors for CBS are closely associated with the treatment and recurrence of head and neck malignancies, including postsurgical infections, wound dehiscence, flap necrosis, and pharyngocutaneous fistulas.[1,5] The risk is elevated in patients with a history of radiotherapy, as radiation-induced necrosis and recurrent head and neck tumors contribute significantly to the weakening of arterial walls.[1]

Because of the severity and acute onset of CBS, treatment is classically thought of as extremely limited and palliative.[6,7] The initial management of CBS usually includes establishing a stable airway, gaining hemostasis, and repletion of blood loss.[5] Subsequent management of CBS includes traditional surgical and endovascular treatment options. Traditional surgical approaches, such as ligation of the CCA or ICA, are now less favored due to high morbidity and mortality rates associated with the compromised state of tissues postradiation or infection.[1,2,8,9] This has led to a shift toward endovascular techniques, which offer a less invasive alternative with potentially lower morbidity rates.[2,8,10] Traditional surgical treatments are generally considered when endovascular options are not feasible or have failed.[11]

Endovascular techniques such as coil embolization, covered stent placement, and balloon occlusion have been reported with success. These methods provide immediate hemostasis, are less invasive, and can be performed under local anesthesia or moderate sedation, which is particularly advantageous in patients with significant comorbidities. Endovascular treatment is indicated for both acute and impending CBS, with the choice of technique depending on the specific characteristics of the hemorrhage (such as the presence of a pseudoaneurysm or active extravasation) and the condition of the patient.[3] It also depends on the location and nature of the arterial injury.

Deconstructive techniques (i.e., coils) are often used to occlude ECA branches either alone or in combination with stents to seal the vessel at the site of rupture or pseudoaneurysm formation.[8] One of the most commonly reported complications of deconstructive endovascular treatment is delayed cerebral ischemia.[8,12,13] In our study, standalone coil occlusion resulted in one large-vessel stroke among four patients, while PVA embolization led to one retreatment need and one septic shock postdischarge among three patients. The MVP system showed one thromboembolic stroke among seven patients.

Reconstructive techniques (i.e., covered stents) allow for the preservation of blood flow through the parent artery and artificially reinforce the vessel wall, thereby lowering the risk for ischemic complications. These techniques are preferred for larger vessel injuries, including those involving the CCA or ICA and are generally deployed to remedy pseudoaneurysms or seal active hemorrhage, offering a rapid and effective means of hemorrhage control with the preservation of blood flow.[2,3,11] However, this approach requires antiplatelet therapy due to the thrombogenic nature of stents and subsequent risk of acute thromboembolism. Because patients with CBS are usually suffering from head and neck cancer, it is necessary to consider how such a prolonged antiplatelet regimen would affect the clinical course of their other conditions.[8] In our study, one of the four patients who underwent covered stent deployment experienced a thromboembolic stroke but recovered, while the other three patients followed a favorable course.

Outcomes of endovascular treatments are promising, with many studies reporting successful immediate hemostasis and low rates of procedural complications. In the meta-analysis by Bond et al, the technical success rate was 100% in both the coiling and stent grafting groups, with 27% rebleeding rate, 11% perioperative mortality rate, and 3% rate of perioperative stroke.[8] Patients treated with coiling appear to

survive longer than those treated with covered stents.[8] However, there is a potential for selection bias since coiling is more commonly used to treat ECA blowout, which is less life-threatening than CCA or ICA blowout. Additionally, the largest to date series of head and neck cancer patients complicated with intracranial CBS who underwent endovascular treatment reported no difference in technical and hemostatic outcomes between the balloon-expandable stents and parent artery occlusion groups among 59 patients with CBS.[14] These findings further validate the broad applicability of various endovascular strategies in complex vascular emergencies.

The long-term outcomes depend on various factors, including the underlying condition of the patient, the extent of cancer, and the occurrence of recurrent CBS. Nevertheless, the long-term survival following intervention is quite poor, given that CBS is often a clinical manifestation of a disease in its late stages.[5,8] Despite these challenges, endovascular treatment modalities are able to afford patients an average of 10 extra months of survival.[8]

Limitations

This study is limited by its small sample size and the lack of a randomized controlled design. Conducted at a single center and focusing exclusively on endovascular procedures for CBS by neurointerventionalists, our findings may not be broadly generalizable.

Conclusion

In conclusion, the current management of CBS heavily relies on endovascular treatment options such as covered stents and coil embolization, which have significantly improved patient outcomes by offering rapid control of hemorrhage with lower morbidity compared with traditional surgical approaches. A multidisciplinary team approach is critical for optimizing treatment strategies and outcomes for patients with this challenging condition.

Ethics Approval

Our institutional review board approved the study design with a waiver of informed consent given the retrospective nature of our study.

Informed Consent

All patients (or their substitute decision-makers) consented to the treatment after a comprehensive discussion of the available treatment options.

Funding

None.

Conflict of Interest

None declared.

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