



Case report

Case report: Selective operative management of zone 3 carotid artery transection

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ABSTRACT

Introduction: Penetrating carotid artery injury is rare and particularly uncommon in zone 3 of the vessel. Due to anatomical challenges to open operative management in zone 3, there are minimal treatment recommendations for this highly morbid condition. The urgency associated with understanding proper management of this traumatic injury is further supported by the nearly 100 % rate of fatality in untreated penetrating carotid artery injuries.

Presentation of case: A 17-year-old male presented with a bullet wound to the right temple. He was intubated for airway protection given left-sided tracheal deviation secondary to a right neck hematoma. His Glasgow Coma Scale (GCS) was 11 on initial presentation, E3V2M6. The patient remained hemodynamically stable and underwent a CT angiogram of the head and neck. Imaging revealed a complete transection of the cervical (zone III) right internal carotid artery (RICA), a large pseudoaneurysm of the RICA distal to carotid bifurcation, and comminuted mandibular fracture. Collateral blood flow was preserved to the right hemisphere. Multi-disciplinary discussions deemed risks of operative intervention outweighed the benefits in the immediate peri-trauma period as the increased risk of hemispheric stroke, exsanguination, and death was thought to be prohibitive. Therefore, treatment of delayed intervascular stenting of the RICA was performed as opposed to emergent open RICA ligation or repair.

Discussion: Treatment decisions for zone 3 CAI rely on the patient's hemodynamic stability, with surgical ligation favored for immediate hemorrhage control in unstable cases, while stable patients may undergo observation or delayed endovascular intervention. Balancing the need for hemostasis to prevent further blood loss with the potential benefits of anticoagulation to maintain cerebral perfusion underscores the decision-making required in managing such cases.

Conclusion: The rarity and challenge of ICA injury at this anatomical location presents unique challenges. Our description of observation and delayed revascularization outlines the precarious, yet validated, treatment method for hemodynamically stable patients.

1. Introduction

Traumatic carotid artery injuries are uncommon and can result from blunt or penetrating mechanisms of injury. Only 12–20 % of penetrating neck trauma is associated with injury to the carotid artery [1]. Carotid artery injuries are classified by anatomic vascular region, defined as [1,2]:

- Zone I – inferior to the cricoid cartilage

- Zone II – superior to the cricoid cartilage and inferior to the angle of the mandible
- Zone III – superior to the angle of the mandible (See

Table 1.)

Carotid artery injuries are more likely to arise from zone II as compared to zone I and zone III [1]. Discussing this patient's injury and treatment decisions will shed light onto this rare pathology with a challenging therapeutic approach.

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Abbreviations

ASA	Aspirin
CAI	Carotid Artery Injury
CTA	Computed Tomography Angiography
E	Eye (part of GCS)
GCS	Glasgow Coma Scale
ICA	Internal Carotid Artery
ICU	Intensive Care Unit
M	Motor (part of GCS)
RICA	Right Internal Carotid Artery
SDH	Subdural Hemorrhage
T	Endotracheal tube (part of GCS)
V	Verbal (part of GCS)

Table 1

Advantages and disadvantages to open and endovascular approaches to penetrating carotid artery injury.

Approach	Advantages	Disadvantages
Endovascular	<ul style="list-style-type: none"> - Minimally invasive - Lower immediate risk of hemorrhage during intervention - Allows for delayed intervention, which may be safer in stable patients - Reduced risk of stroke if cerebral perfusion is maintained 	<ul style="list-style-type: none"> - Limited access to distal control of the vessel - Requires specialized equipment and expertise - Potential for incomplete repair in complex injuries - Difficult in cases with severe vessel transection or extensive pseudoaneurysm
Open surgery	<ul style="list-style-type: none"> - Direct access to the injury site, allowing for immediate control of hemorrhage - Suitable for hemodynamically unstable patients requiring urgent intervention - Can address complex injuries including those with extensive vascular damage or complete vessel transection 	<ul style="list-style-type: none"> - Highly invasive, with significant risk of complications including exsanguination and stroke - Challenging in anatomically complex zones, such as Zone III, due to surrounding bony structures - Higher risk of morbidity and mortality, especially in the presence of difficult anatomy or extensive injury

2. Presentation of case

A 17-year-old male presented to the hospital after sustaining a gunshot wound to the right temporal region. On primary survey, the patient was found to have blood in the oropharynx and garbled speech. Breathing was labored but his lungs were clear to auscultation bilaterally. His oxygen saturation was 100 % on low flow, nasal canula supplemental oxygen. Circulatory exam revealed an absent right carotid pulse with right neck hematoma and leftward tracheal deviation, otherwise normal. Glasgow Coma Scale (GCS) was 11 (E3V2M6) on arrival. The patient was orally intubated for airway protection.

On secondary survey the patient was found to have blood in the right external auditory canal. The trachea was found to be deviated to the left with a palpable, non-expanding, non-pulsatile hematoma in the right neck. Prior to intubation and sedation, neurological exam revealed 5/5 strength in all four extremities, normal range of motion, and the ability to follow commands in all extremities. There was a notable right-sided facial droop.

Given the patient's hemodynamic stability, he was taken for computed tomography angiography (CTA) of the head and neck. CTA head revealed minimal subdural hemorrhage (SDH) along the right parietal lobe adjacent to the sagittal sinus with anterior communicating

artery patency providing collateral cerebral perfusion. CTA neck identified a right cervical ICA pseudoaneurysm measuring 2.5 cm by 1.5 cm by 2.2 cm just distal to the carotid bifurcation at the skull base. The findings were indicative of a complete ICA transection as there was no contrast distal to the pseudoaneurysm. Defining the zone of injury proved challenging due to vascular pathology effectively bridging zone II and III.

Following multidisciplinary discussions, the decision was made to defer immediate operative management. All specialists were concerned about the ability to achieve distal control right ICA with surrounding bony features which could lead to exsanguination and stroke. Endovascular intervention was considered; however, the consultant team was concerned that the right ICA was completely severed, making stent deployment impossible.

In the acute period, the right neck hematoma was stable in size and the patient's neurologic exam remained GCS 11T and no evolving neurologic deficits. Overall, the patient's hemodynamic stability, collateral blood flow to the right brain, and secure airway indicated that the benefits of ICU observation outweighed the risks of immediate intervention.

Follow-up 48-h CT head indicated a stable SDH and evolving right carotid pseudoaneurysm while a 6-day follow-up CTA head found a frontotemporal perfusion deficit and further evolving right pseudoaneurysm. On post-injury day 7, neuro-interventionalists attempted right ICA stenting that failed due to an identified dissection flap obscuring 70 % of the vessel. On post-injury day 19, the petrous bone was debrided with auditory canal closure to address tissue damage leading to blood pooling in the ear. Finally, after interval CTA demonstrated an improvement of the pseudoaneurysm, neuro-interventionalists successfully coiled the right ICA.

In terms of anticoagulation, the patient remained on daily aspirin (ASA) 81 mg starting hospital day 7 to 18. Plavix was started with 600 mg prior to neuro-interventional procedure on day 19. Following revascularization, the patient was continued on Plavix every other day, as he was found to have an exaggerated response to the medication based on P2Y12 reaction units testing.

The patient was discharged home with tube feeds through a percutaneous endoscopic gastrostomy tube. Speech pathology and physical therapy assessments were obtained, and the patient was able to return to his home with home health care on post-injury day 32. The patient remained on ASA daily and Plavix every other day for 6 weeks post-stent placement.

3. Discussion

CAI from penetrating trauma to zone III is a rare pathology that remains significantly challenging to address in of the neck. Though literature exists on this specific pattern of injury, minimal formal recommendations are available.

Current literature suggests that treatment of penetrating ICA injury depends heavily on hemodynamic status [3,4]. In the case of hemodynamic instability, open surgical ligation of the ICA should be pursued for immediate hemorrhage management and stroke prevention with delayed carotid bypass [3,4]. In the case of hemodynamic stability, there are several options that have been proposed. When the injury of the vessel is determined by CTA to be full thickness, balloon occlusion has been utilized to tamponade free extravasation [3]. However, when the CTA indicates partial thickness injury, like the creation of a pseudoaneurysm in our patient, a more conservative approach is taken with initial observation and delayed endovascular treatment [3,4]. Additional studies also indicate the value of ICA bypass in the hemodynamically stable patient [4]. Technological improvements in four-vessel angiography have provided a majority of the consensus around clinical observation and urgent multi-disciplinary care over emergent surgical neck exploration [5]. The treatment plan for this patient involved recognizing the potential harms of early intervention on a

hemodynamically stable patient and pursuing observation with delayed revascularization. This strategy appears to align with minimal literature on the subject.

An additional challenge to this case involved the conflicting need for hemostasis and anticoagulation. A penetrating carotid artery injury, particularly one that is filling a pseudoaneurysm or extravasating, necessitates hemostasis to prevent further blood loss. On the contrary, cerebral hypoperfusion from CAI often calls for anti-coagulation to restore optimal blood flow and prevent embolic stroke [6]. Overall, the decision was to defer acute operative intervention given an increased risk of exsanguination of the right neck hematoma and potential for hemispheric stroke. Additional risks of surgical intervention in the acute period involves developing a dissection flap with endovascular instrumentation and rupture of the ICA pseudoaneurysm.

Future cases should be evaluated to consider the patient's anatomic injury, physiologic status, and clinical exam. In this case, the patient was young and healthy, and he maintained collateral cerebral circulation through a complete Circle of Willis [7]. These factors undoubtedly played a role in the favorable outcomes observed with no enduring neurological or vascular impairments. The key feature in this decision-making process relied on early airway access, patients without a definitive airway would likely be unsuitable for delayed treatment as described. All data described has been in line with SCARE criteria [8].

4. Conclusion

This case presents a 17-year-old male with a zone III penetrating carotid artery injury. The rarity and challenge of ICA injury at this location presents unique challenges. Our description of observation and delayed revascularization outlines the precarious, yet validated, treatment method for hemodynamically stable patients. Specifically, the patient was temporized in the ICU for 7 days with interval head imaging. The patient was able to receive carotid revascularization on hospital day 19 and began Plavix anti-platelet therapy. Overall, this patient experienced a favorable outcome with delayed endovascular management, rather than open surgical repair, that can be mostly attributed to the timely establishment of airway access, hemodynamic stability throughout, and maintenance of collateral cerebral perfusion.

Ethical approval

Single patient case report is not considered research at University Hospitals Cleveland, OH.

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Author contribution

Brian Foresi – original draft, reviewing & editing.
Ananya Tawde – data curation, reviewing & editing.
Amy P. Rushing - reviewing & editing.
Matthew L. Moorman – supervision, data curation, reviewing & editing.

Guarantor

Brian Foresi and Matthew Moorman accept the role of guarantor and full responsibility for the work and conduct of the study.

Research registration number

No registry used in this study.

Conflict of interest statement

Authors state they have no conflicting interests financially or otherwise.

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