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## Short Communication

## Acute and Delayed Cerebrovascular Injury From Gunshot to the Head in a 12-Year-Old Child During the COVID-19 Pandemic

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The risk of gun injuries in American children almost doubled in the first 6 months of the COVID-19 pandemic.<sup>1</sup> Gun violence overall increased 30% the first year of the pandemic.<sup>2</sup> Gunshot injuries to the head and neck can cause neurovascular injury and stroke, but management of ballistic cerebrovascular injury is not well described

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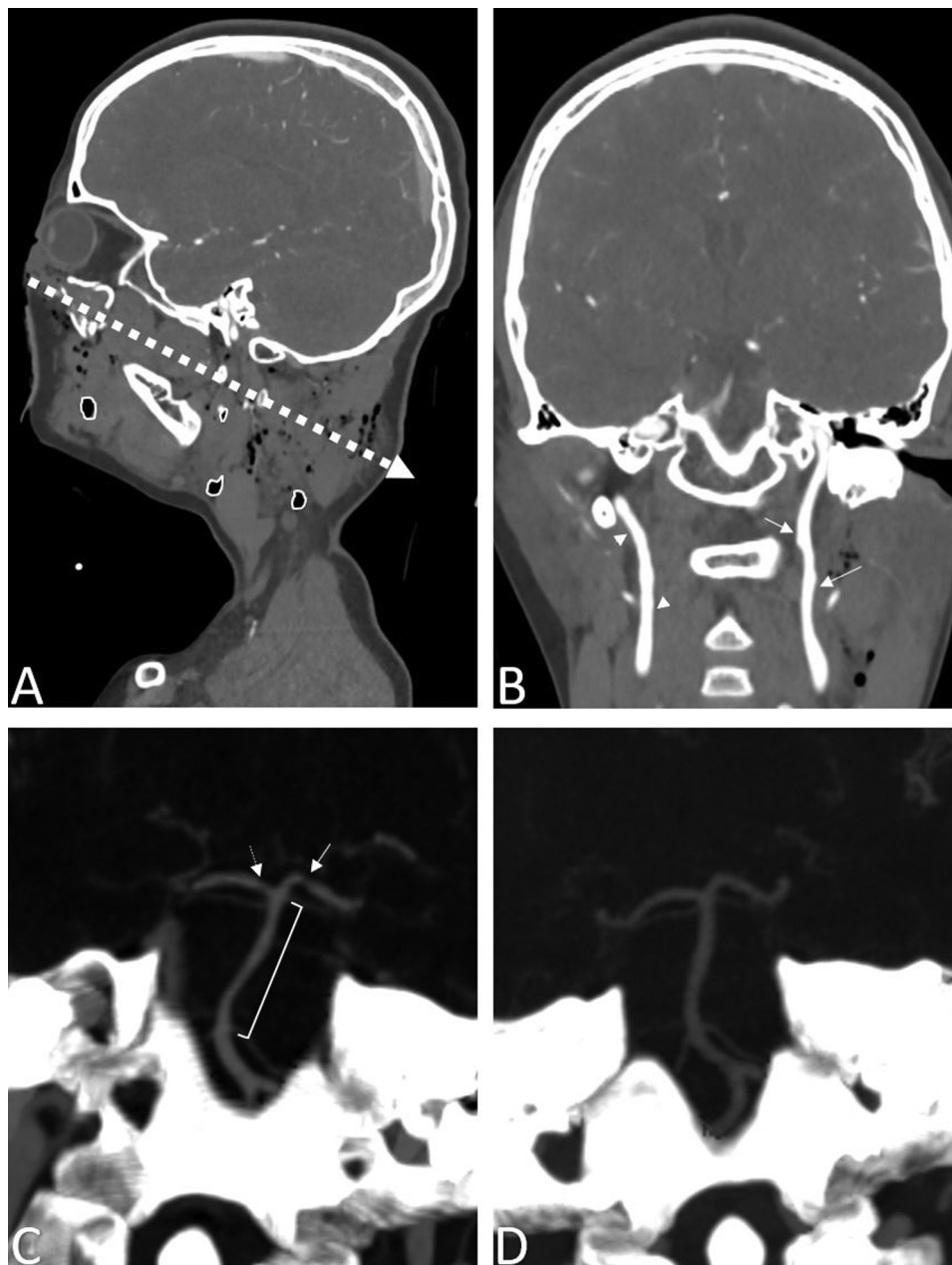
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in the pediatric stroke literature. We present a child shot during the pandemic who had significant acute and delayed cerebrovascular injury, but no stroke, likely due to medical management.

In December 2020, a 12-year-old boy was shot in the face by his sister’s friend, who was playing with a loaded gun. The boy yelled he was shot; his mother called 911. He was intubated in the emergency room. Computed tomography (CT) and CT angiography (CTA) revealed comminuted fractures of multiple facial bones, including the left orbital floor and left maxillary sinus. The ballistic tract extended from the left infraorbital soft tissues inferiorly and posteriorly through to the left perivertebral paraspinous spaces (Fig), with multifocal luminal irregularity of the bilateral mid and distal cervical internal carotid arteries (ICAs).

He was admitted to the intensive care unit. Aspirin 81 mg/day was started for stroke prevention due to concern for ICA dissections. He received prophylactic antibiotics and pain control. He was extubated the next day and discharged home 3 days after admission, with no focal neurological deficits. He returned 4 days later, complaining of numbness of the mouth, upper and lower teeth, and bilateral thighs; thigh numbness resolved in the emergency room.



**FIGURE.** (A) Sagittal CTA of the head and neck shows the trajectory of the bullet (dotted arrow) entering below the left orbit and exiting the neck posteriorly. Subcutaneous emphysema extends along the bullet tract (outlined in white). (B) Coronal CTA neck shows irregularity of the cervical segments of the internal carotid artery bilaterally, right (segment of subtle irregularity spanning between the arrow heads) worse than left (arrows) representing vasospasm. The basilar artery and PCA were unremarkable (not shown). (C) 6 days later the patient developed facial and lower extremity numbness. Follow-up coronal CTA head showed irregularity of proximal posterior cerebral arteries (right dotted arrow, left arrows) and narrowing of the basilar artery (bracket) not noted on prior CTA representing dissection. (D) Follow-up coronal CTA head 2 months later showed resolution of basilar and posterior cerebral artery irregularities representing interval healing. CTA, computed tomography angiography; PCA, posterior cerebral artery.

Repeat CTA revealed improved patency of both ICAs but new, severe long-segment smooth narrowing of the P2 segment of the right posterior cerebral artery, severe short-segment narrowing of the P1 segment of the left posterior cerebral artery, and mild smooth narrowing of the basilar artery, all suggesting vasospasm. Intravenous fluids were started at 1.5 times maintenance, and norepinephrine was used to maintain systolic blood pressure at 120-140 mmHg. Magnetic resonance angiography 1 day later, conventional angiography 3 days later, and repeat CTA 1 week later demonstrated persistent posterior circulation vasculopathy, most likely

vasospasm. COVID-19 polymerase chain reaction test for fever was negative. Verapamil was initiated and titrated up to 80 mg tid. At neurology clinic follow-up 3 weeks post discharge, neurological examination was normal. Repeat CTA 5 weeks post discharge showed improved posterior circulation flow, and verapamil was weaned off.

Both vascular dissection and vasospasm are known complications of gunshot injury to the head and neck in adults,<sup>3</sup> but rarely reported in children.<sup>4,5</sup> Vasospasm may occur days after initial injury, usually triggered by subarachnoid hemorrhage (SAH). Small

amounts of SAH may not be visible on intracranial imaging. We did not see SAH in our patient but suspect it was present due to bullet injury. Dissection may also become more obvious with time after injury due to edema and hemorrhage into the vascular wall. It is possible that some of the posterior circulation injury was delayed presentation of dissection.

Ssentongo et al.<sup>2</sup> pointed out that the increase in gun violence during the pandemic may represent more of a risk to children's health than COVID itself. Reasons proposed for the increase in gun violence during the pandemic included increased stress levels and increased gun sales.

Our patient's outcome was surprisingly good, with no progression to infarction despite significant anterior and posterior circulation vascular injury. We believe his treatment with aspirin, hydration, norepinephrine, and a calcium channel blocker (verapamil) all contributed to the prevention of stroke in this patient. We suggest early vascular imaging and repeat vascular imaging in other

children with gunshot injury to the head to prevent more devastating cerebral injury.

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