An Unusual Cause of Cerebral Infarction in a Tanzanian School Child

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Abstract
Pediatric stroke is uncommon. A traumatic cause of pediatric ischemic stroke is even rarer. Ischemic stroke due to intraluminal thrombus can be acutely treated with thrombolysis but various factors in sub-Saharan Africa make this unfeasible. We present a case of an eight-year-old Tanzanian boy who sustained penetrating trauma to his palate developing an ischemic stroke of his right middle cerebral artery territory.

Keywords
middle cerebral artery, pediatric, stroke, trauma, Tanzania

Introduction
Oral trauma in playful children is common and usually benign, but cerebrovascular injury following oral trauma is rare1,2. Due to its excessive rarity, stroke such as that involving oral trauma in children often has a diagnostic delay. Due to its relatively straight orientation and wide vessel caliber, the middle cerebral artery (MCA) is most commonly affected in ischemic stroke3,4. Acute neurological facilities such as neurologist assessment and neuroimaging are scarcely available in Tanzania with approximately 59.7 million inhabitants5. There is 1 neurologist per 8–10 million inhabitants, and only 2 MRI scanners and 6 CT scanners in the North of the country available. Intravenous or intra-arterial thrombolysis is unavailable but for one private hospital in the largest city Dar-es-Salaam6. We present a case of a boy from rural Tanzania (East Africa) with penetrating oral trauma complicated by ischemic stroke.

Case Presentation
An eight-year-old boy presented to us with one day history of penetrating oral injury after a fall, and subsequent left sided weakness. The mother reported that her child was at school, sitting on a swing with a pencil in his mouth. He fell off the swing, face-first to the ground. The pencil punctured his palate which resulted in bleeding. Another child removed the pencil from his mouth. The child complained of pain in the mouth and headache. The weakness started approximately four hours after the injury, and progressively affected his left upper and then lower limbs a matter of a few hours. On initial exam one day post injury he was fully conscious and alert with GCS of 15/15, both pupils equally reacting to light and left sided hemi paralysis with power Medical Research Council (MRC) grade 0/5. The child was drowsy but arousable, with dysarthria but no aphasia. Cranial nerves were intact except a central facial weakness on the left side. There was a puncture wound on the right side of his palate that was not actively bleeding but hyperemic (Figure 1). A CT-scan revealed a large wedge shaped ischemic infarction involving the right MCA territory (Figure 2).

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vital signs from admission to discharge were stable and fundoscopy was normal. MRI brain was done two days later and showed thrombosis in the distal M1 branch of the right MCA with associated large MCA territory infarction involving right fronto-parietal lobe and right basal ganglia. There was hemorrhagic transformation of the right putamen and anterior limb of the internal capsule, pressure effect on the right lateral ventricle with 6mm midline shift towards the left. The circle of Willis was intact with normal flow (Figure 3).

The boy was kept on IV antibiotics which included chloramphenicol 500mg IV three times a day for 5 days and benzyl penicillin 2.5MU four times a day for 5 days. The child got physiotherapy and occupational therapy assessment and was discharged after 5 days with minimal improvement of power in left leg and arm to MRC grade 2/5. Over the next one-year period, he developed a spastic hemiplegia MRC grade 3/5, mild dysarthria with ability of naming objects and intact comprehension, and no problems swallowing. He resumed school six months after his injury, and walks to school from his house every day. He continues with physiotherapy and gets maintenance baclofen 5mg three-times daily.

**Figure 1.** Puncture wound (yellow arrow) on the palate.

**Figure 2.** Images A-D: Non-contrast axial brain CT shows a large wedge shaped ischaemic infarction in the right fronto-parietal lobe and right basal ganglia with loss of grey white matter differentiation involving the right middle cerebral artery territory. Dense right middle cerebral artery seen in image D in keeping with thromboembolism.

**Discussion**

The global burden of childhood stroke ranges from 1.3 to 13 per 100,000 patients with a mortality of 3.6%. Despite the plasticity of the growing brain, stroke in children still has a substantial case fatality rate of up to 4%. Literature review showed 32 cases involving soft palate injury that resulted in thrombosis and neurological complications. The estimated rate of stroke with soft palate injury is only less than 1%.

The onset of symptoms post injury varies but mostly neurological deficits occur after a “lucid” period of time 3–60 h post injury. These cases present with features of stroke such as in our case who presented with hemiparesis four hours after the injury. A case presented by Rose et al developed tonic-clonic seizure 4 days post injury without paralysis whereas the case presented by Suskind et al had an asymptomatic ICA thrombosis. This shows the variations in the symptoms and their onset after an assault.

Treatment of penetrating injuries to the soft palate resulting in pediatric stroke is still debatable. No standard treatment has been proposed, although studies showed treatment mostly based with the severity of patient presentation. Treatment can be classified as that aiming on acute intervention or secondary prevention, which bases on the nature of stroke and period in which is diagnosed. Usually acute intervention involves...
Figure 3. Images A-C: Diffusion weighted imaging (DWI). Images D-E: ADC maps. Image F-G: TOF brain angiography. MR imaging of the brain show diffusion restriction of the right fronto-parieto-temporal lobe with involvement of the right basal ganglia on DWI. There is corresponding low signal intensity on ADC map images suggestive of acute large right middle cerebral artery territory infarction. TOF angiography of the brain shows occlusion of the petrous, cavernous and cerebral part of the right internal carotid artery (ICA) and the distal M1 branch of the right middle cerebral artery (MCA) secondary to thromboembolism.
Table 1. Summary of Comparison of Cases with Penetrating Injury to the Oral Cavity.

| Authors, year | Age and sex | Symptoms onset | Typical stroke pattern | Management | Outcome |
|---------------|-------------|----------------|------------------------|------------|---------|
| Pitner, 1966 | 22 months, Female | Fell on toy arrow Right hemiparesis, pupil dilatation, bilateral papilledema Symptoms 24 hours later | N/A | Intravenous urea | Died fifth day in hospital |
| Suskind et al, 1997 | 3 years, Male | Fell with a flag stick, Neurological intact | Magnetic resonance angiography showed narrowing of ICA, no neurologic deficit reported | Kept on heparin, since had ICA thrombosis, junior aspirin after discharge | Discharged after 7 days |
| Pierrot et al, 2006 | 4 years 6 month Female | Fell against door handle with mouth open, injuring soft palate, 24 hours later had left hemiplegia, central facial palsy, aphasia | CT scan and MRI showed right ICA thrombus with decreased MCA blood flow, right insular cortex hyper intense | SC LMWH, for 4 months, followed by 100 mg/d of aspirin | Had hemiparesis lasting 10 minutes, 24 h post injury, never developed again after 10 months follow up |
| Marzabadi et al, 2011 | 2 years 6 months, Female | Fell with a pencil injuring her palate, Symptoms started 17 h later | Right hemiplegia, uvular deviation to the left side, Brocaaphasia CT showed hypo dense area in MCA territory | Kept on aspirin 15 mg/kg/ day | Not reported |
| Bent et al, 2015 | 16 months, Female | Felt with tooth brush injuring her palate, 16 h later she vomited. 22 h post event diminished left extremity movement GCS 10–12 | CT showed large right MCA with midline shift | Kept on levetiracetam for seizure, prophylaxis, hypertonic saline for ICP Decompression craniotomy | 4 months later, able to walk with difficulty power 4/5 left upper and lower limbs |
| Aggarwal, 2017 | 7 years old, Male | Injury to left side of soft palate, symptoms occurred 9 h after, headache, vomiting right sided weakness. | CT showed MCA territory infarction, CT angio of neck showed non filling ICA | Decompressive hemi craniotomy heparin started | Power improved from 2–3/5 on the right side |
| Rose et al, 2019 | 2 years old, Female | Injured her palate with tooth brush after fall Developed tonic clonic seizure 4 days after injury | CT scan showed hypo dense area at junction of parietal-temporal lobe, CT angio showed occlusion/thrombosis of left ICA | Aspirin 80 mg, enoxaparin and oxcarbazepine for seizure | No seizures after 4 months post discharge |

Thrombolysis or endovascular therapy, while secondary prevention uses anticoagulants and antiplatelet. Both antiplatelet and anticoagulant agents reduce the risk of stroke but which therapy is superior remains unknown. There is limited evidence on the newer factor Xa inhibitors antithrombin agents. Challenge remains in creating evidence-based guidelines on the newer factor Xa inhibitors antithrombin agents. Therapy is superior remains unknown. There is limited evidence anticoagulant agents reduce the risk of stroke but which antiplatelet and thrombolysis or endovascular therapy, while secondary prevention uses anticoagulants and antiplatelet. Both antiplatelet and anticoagulant agents reduce the risk of stroke but which therapy is superior remains unknown. There is limited evidence on the newer factor Xa inhibitors antithrombin agents. Challenge remains in creating evidence-based guidelines on the newer factor Xa inhibitors antithrombin agents.

As summarized by the Table 1 highlighting cases with similar mechanism of injury like the presented case, two cases which showed increased intracranial pressure, decompression craniotomy was done as an emergency procedure. For our case where availability of neurosurgery services is still a challenge, conservative management was the best remaining option. For our patient apart from MRI of brain which showed MCA infarct the CT showed signs of increased ICP however clinically the patient had no signs of this and furthermore he had a normal fundoscopy therefore no drugs or surgery was indicated to lower ICP, but rather was kept in elevated neutral head position.

Antiplatelet drugs were not given to our patient because there is no convincing evidence for this post traumatic dissection and there were financial restrictions not allowing for daily medication. Salicylic acid is most useful when started early, and the child incurred diagnostic delays due to affordability of MRI brain. The evidence for aspirin in traumatic dissection in children is not strong due to rarity and therefore a small sample size. In addition, because of the size of the infarction, blood vessel wall trauma and clinical drowsiness, it was decided to not start salicylic acid in this stage due to risk of bleeding. Nonetheless, our patient was managed conservatively with physiotherapy and low dose of baclofen for muscle spasms and fared well returning to routine.
It is observed that for most cases with penetrating injury to the palate without evidence of stroke or neurological deficit the morbidity is extremely low\textsuperscript{17}. Soose \textit{et al} conclude in their report that the incidence of neurologic sequelae is low after oropharyngeal trauma, routine imaging cannot be emphatically recommended nonetheless they prefer imaging for lateral oropharyngeal trauma regardless of wound severity\textsuperscript{18}. In another report by Bent \textit{et al} state that the small long-term risk of CT radiation-induced malignancy may outweigh the potential stroke risk in neurological intact children however MR angiography can be an alternative. They also add that current recommendations for advanced imaging are indicated for patients with large intraoral laceration, persistent bleeding, expanding hematoma and neurologic deficits\textsuperscript{14}. In most cases described by other authors, resources allowed for intervention radiology or longer term secondary drug prophylaxis. Both are less feasible in the circumstances described for our patient.

**Conclusion**

Oral trauma is common in pediatric age group, but stroke following oral trauma is uncommon. In appropriate healthcare settings, rapid neurological diagnosis and emergency imaging of the brain in case of arterial occlusion might result in timely thrombolysis and reversal of neurological symptoms. A stark contrast exists with respect to this unfortunate ‘pencil case’ from Tanzania. Rehabilitation was the only available therapy but it allowed the child to resume school some months after the injury.

**Consent**

Written informed consent was obtained from the child’s mother for publication for this case report; additionally, accompanying images have been censored to ensure that the patient cannot be identified. A copy of the consent is available on record.

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**Authors’ Contributions**

JL, HC and MD conceptualized and prepared the manuscript. KK and KB reviewed the medical records. AS prepared and reported the radiology images. All authors have read and approved the final manuscript.

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