Delayed death after hyena bite in a 3-year-old Tanzanian boy: the unique reality of neurosurgery in a resource-limited setting

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A 3-year-old boy presented after a hyena bite to the skull in Tanzania. A large degloving wound with herniating cerebrum was seen in the right parietotemporal region. A CT scan confirmed a large 8-cm skull defect. The patient was taken for irrigation and debridement, but due to significant tissue loss, the skin could not be closed. CSF leaked from the wound, and two additional operations for attempted closure were undertaken but failed. The plastic surgery team was consulted, but no closure was done because of the procedure's complexity, lack of resources, and cost. CSF diversion could not be performed due to no available lumbar catheter or external ventricular drain. Meningitis developed, leading to severe hyponatremia and death. The current case highlights both the unique mechanism of a hyena bite requiring neurosurgical intervention and the realities of practicing neurosurgery in a low-resource setting.

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NEUROSURGEONS in low- and middle-income countries (LMICs) face complex patient presentations, rare etiologies, and end-stage pathology, all with limited resources. The country of Tanzania has 2 tertiary centers that offer comprehensive neurosurgical care for an in-country population of more than 57 million people (<http://datatopics.worldbank.org/world-development-indicators/>). The centers also provide care for an additional 13 million from the neighboring countries of Mozambique, Zambia, Rwanda, Burundi, and the Democratic Republic of the Congo.⁷

While animal attacks requiring neurosurgical intervention have been reported,^{2,4,5} those that occur in LMICs present unique challenges.^{1,11,12} Four prior reports exist that describe hyena injuries,^{6,7,9,10} all from sub-Saharan Africa, totaling 18 cases spanning the ages of 5–50 years. Each patient recovered fully. Most cases involved head and neck lacerations, yet no skull fractures, dural involvement, or traumatic brain injuries have been reported.

Here, we present the case of a 3-year-old boy who sustained a hyena bite causing a large skull defect. Due to the rarity of this mechanism, young age of the patient, com-

plex postoperative course, and ultimate death, we believe that this report highlights the reality of practicing neurosurgery in an LMIC setting.

Case Report

History

A 3-year-old boy (14 kg/100 cm) presented to the emergency department of a major Tanzanian referral center, Muhimbili Orthopaedic Institute (MOI), with a 1-day history of a hyena bite to the head. The patient came from the Lindi Region, which borders the largest national park in Tanzania known as the Selous Game Reserve. The child had been circumcised according to cultural rituals 2 days prior to the attack, and the penile wound was healing appropriately in his family's hut. At night, a hyena broke down the door to the hut, entered the boy's room, and attacked the right side of his head. The hyena bite was likely incited by the smell of blood and a fresh wound.⁹ The child originally presented to a local dispensary and, after the extent of his injuries was noted, was transferred to MOI.

ABBREVIATIONS EVD = external ventricular drain; LMIC = low- and middle-income country; MOI = Muhimbili Orthopaedic Institute; POD = postoperative day; VP = ventriculoperitoneal.

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FIG. 1. Three-dimensional skull CT reconstruction with a large right parietotemporal defect.

Examination

On examination, the child had intact cranial nerves, and all extremities appeared to be full strength and symmetric. A large, right parietotemporal, foul-smelling scalp degloving wound was seen. The periosteum, calvaria, and meningeal elements were visible, in addition to small areas of parietal and temporal cerebrum. Obvious CSF leakage was also seen. A CT scan confirmed an 8-cm parietotemporal bone defect with minimal traumatic subarachnoid hemorrhage (Fig. 1). The patient's hemoglobin on admission was 4.0 g/dl, and he immediately was transfused a single unit of blood. The patient received 260 U of an antirabies immunoglobulin, and broad-spectrum antibiotics (cefuroxime, amoxicillin-clavulanate, gentamicin) were started immediately.

Operation

Given the good neurological examination and stable vital signs, the appropriate transfusions and vaccinations were given, and the child was taken to the operating room for surgical debridement and attempted primary closure of the wound on hospital day 2. Intraoperatively, immediate cultures were taken. Necrotic skin edges were resected until healthy scalp was seen. Visible cerebrum that had herniated through the craniectomy defect was also resected. The entire wound was copiously irrigated with normal saline mixed with gentamicin. The remaining pericranium was harvested, and a duraplasty was performed. Although the scalp defect was large, an attempt at skin closure was made but could not be completed (Fig. 2).

Postoperative Course

On postoperative day (POD) 1, the child remained at

FIG. 2. Photograph of the scalp wound on the right side immediately after surgical debridement. Figure is available in color online only.

his neurological baseline; however, a small, slow CSF leak was noted and treated conservatively with sterile dressing changes and head elevation. Broad-spectrum antibiotics were continued for 2 weeks, in addition to Diamox to slow the CSF leak. Although cultures were drawn, they were not processed due to cost, as the patient's family had no insurance. The plastic surgery team was consulted and advised wound dressing with sterile gauze without immediate surgical intervention. In the coming days, the wound was dressed 3–5 times per day with saline, topical mupirocin antibiotics, Vaseline gauze, iodine, and honey for tissue regeneration.³ The wound status improved significantly (Fig. 3).

On POD 7, CSF continued to leak from the wound. This prompted 2 additional operations in an attempt to close the dural defect, with adjacent pericranium on POD 8 and an artificial patch (DuraGen, Integra LifeSciences) on POD 10, which was donated by a visiting surgical team (Fig. 4A). Although slowed, CSF continued to leak. CT scans were obtained on hospital day 12 and initial POD 11 (4 and 2 days after the additional operations) and showed ventriculomegaly with asymmetrical dilation of the ipsilateral occipital horn (Fig. 4B).

The needed CSF diversion unfortunately could not be done for multiple resource, social, and financial reasons. First, neither a lumbar catheter nor an external ventricular drain (EVD) was available. Second, the hospital administration was hesitant to take apart a shunt for use of only the proximal catheter, as another patient could have used the entire ventriculoperitoneal (VP) shunt system for hydrocephalus treatment. A contralateral VP shunt was also not done over concern for permanent hardware placement in an active infection. Third, the ICU nursing care required for a 3-year-old patient with an EVD could not be provided due to a full ICU with mechanically ventilated traumatic brain injury patients and a lack of familiarity

FIG. 3. Photograph of the wound on hospital day 8. Figure is available in color online only.

with EVD care in a child. Moreover, a collection bag was not available.

With an open scalp wound and continued CSF leak, the plastic surgery team was reengaged for scalp closure. However, they were not able to pursue further operative wound closure due to a lack of resources and cranioplasty options, and the complexity of a skin graft. During the 4th week of hospitalization, the child developed a fever to 101.8°F along with neck stiffness. Vancomycin and meropenem were initiated to cover for a presumed meningitis. A final attempt to look for a bone substitute was done but unsuccessful. Severe hyponatremia ensued, and the child died of refractory meningitis and electrolyte imbalance.

Discussion

We present the case of a 3-year-old boy who suffered a hyena bite in East Africa, causing a severe cranial defect that resulted in a persistent CSF leak, meningitis, and death. The environment of practicing medicine in an LMIC, among other reasons, prevented the CSF leak from being adequately treated and the complex plastic surgery reconstruction that was required. This case highlights a rare animal attack requiring neurosurgical treatment and reinforces the reality of practicing neurosurgery in a resource-limited setting.

The mechanism alone, a hyena bite to a young child, is in itself worthy of discussion. In our literature search, we found 18 cases of hyena attacks in 4 reports,^{6,7,9,10} and all included similar circumstances. Hyenas attack weakened prey, based on appearance, behavior, and scent,⁹ and use their heavily muscled jaws to tear away flesh from the head and neck region.⁶ In their series of 4 hyena attacks in Ethiopia, Fell et al.⁶ reported on 2 children (5 and 7 years old) who were both playing in a field, one of whom was the smallest of the group and the other was alone;

FIG. 4. Photograph of the wound on hospital day 11 (A) and CT scan obtained on hospital day 12 (B), showing a dilated right occipital horn and craniectomy defect. Figure is available in color online only.

a 15-year-old boy who was sleeping alone outside guarding cows; and a 50-year-old woman who was the slowest runner among a group. Our case is no different, where a 3-year-old boy appeared small and weak after a recent surgical procedure.

Descriptions of how to treat hyena attacks are similarly sparse. Gilyoma et al.⁷ reported the largest series of 12 hyena attacks among 322 animal-related injuries from northwest Tanzania; however, no specific information regarding each case was included. Mitchell et al.¹⁰ described a 27-year-old woman who suffered a hyena bite causing face, hand, and elbow soft-tissue injuries, yet after antibiotics, vaccination, and routine skin closure, she made a full recovery. Lavee et al.⁹ reported on a 7-year-old Ethiopian boy who was attacked by a hyena and sustained an amputated right auricle, damaged right globe, destructed mandible, and open scalp wound. After hospitalization in Ethiopia for 2 months, he was transferred to an Israeli center for a 2-stage scalp, ear, and mandible reconstruction and made a full recovery. Lastly, in the series of 4 cases presented by Fell et al.,⁶ all patients underwent complex facial reconstruction by a team of visiting plastic surgeons. All patients were treated in a delayed fashion, meaning that instead of infection and survival being the major concerns, the surgeons could focus on reconstruction only.

Dog bites are similar yet more common injuries, and comparison to the current case highlights interesting management differences between high- and low-income countries. Ten patients bitten by dogs were retrospectively reviewed from a major US trauma center.¹³ Five of 10 patients (50%) required surgical intervention, including wound debridement, removal of comminuted skull fracture, and primary dural repair. Involvement of additional surgical teams was required in 8 cases (80%). A larger retrospective review from another US trauma center reported 124 children with dog bites to the head, face, and neck, of whom 17 (14%) required neurosurgical consultation and 10 required neurosurgical intervention (8%).⁸ In one of these cases, a 9-month-old boy was attacked by the family's American Bulldog, leading to a large scalp defect, skull fracture with exposed brain, and intracranial hemorrhage. After decompressive craniectomy, the boy underwent EVD placement twice, debridement and washout twice, and VP shunt placement. *Klebsiella* and

Pseudomonas spp. infections and a fungal infection developed during his hospital course. The large scalp defect was treated with a split-thickness graft, with the intention for a free flap at a later date. The child in question received high-level care, in sharp contrast to our current case. One wonders whether CSF diversion, skin graft, specific antibiotics, and plastic surgery assistance had been available, the life of the child in our report might have been saved.

In an effort to maximize learning from the death of this child, 3 noteworthy themes arise regarding neurosurgical care in low-resourced settings. First, the indicated scalp reconstruction could not be performed. Without adequate resources and an experienced plastic surgery team to perform the complex scalp reconstruction, the wound remained open. Second, CSF could not be diverted due to the lack of a lumbar catheter or EVD. The patient could not have a contralateral shunt placed due to an active infection, and an endoscopic third ventriculostomy was discussed but not pursued due to concern for sepsis. Sadly, seemingly simple, affordable resources were not pursued. Third, while broad-spectrum antibiotics to treat the meningitis were used, specific culture data were cost-prohibitive and not obtained. No single reason was insurmountable, yet the buildup of several multifactorial hospital, cost, and social reasons could not be overcome. We must recognize the role of both the individual providers—surgeons, nurses, administrators—and the institution as a whole, to not address the CSF leak. It is likely that the cost of 3 operations and antibiotics far outweighed the cost of a shunt, alluding to the notion that institutional and cultural forces may sometimes overpower basic logic. That said, while treating the CSF leak may not have ultimately saved this patient, it would have helped. Simply blaming “the system” is substandard.

With these learning points in mind, what can be done to prevent scenarios like this from occurring? First, when complex pathology is encountered, transfer to a better-equipped setting may be necessary. Though costly, additional expertise and resources were facilitated by the Israeli embassy⁹ and a visiting medical team⁶ in prior reports. Second, government aid can assist in the cases of injury or death due to wildlife.^{1,12} Third, in the case of complex infections, lobbying for culture data and antibiotics may be possible. MOI has a Department of Social Welfare that routinely engages philanthropists and charity organizations such as mosques and churches. Fourth, when institutional culture seems to overpower logical treatment decisions, like-minded physicians should join together and confront administration to lobby for the needed resources.

The current case report is not without limitations. We cannot draw conclusions about all LMICs or large regions in sub-Saharan Africa based on one patient. To get a more accurate description of the problem of hyena attacks in Tanzania, it would be useful to contact local hospitals, clinics, and health posts to examine their admission records.⁶

Conclusions

The current case highlights the challenges of practicing neurosurgery in a limited-resource setting and the uniqueness of a hyena bite requiring neurosurgical involvement.

The reason for the child's death was multifactorial and may have been prevented with additional resources. The current case enforces the current limitations of practicing neurosurgery in a resource-limited setting.

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Disclosures

The authors report no conflict of interest concerning the materials or methods used in this study or the findings specified in this paper.

Author Contributions

Conception and design: Zuckerman, Magogo Mzimhiri. Acquisition of data: Mkony, Magogo Mzimhiri. Analysis and interpretation of data: Zuckerman, Mkony. Drafting the article: Zuckerman, Mkony, Magogo Mzimhiri, Leidinger, Bonfield. Critically revising the article: all authors. Reviewed submitted version of manuscript: Zuckerman, Magogo Mzimhiri, Leidinger, Bonfield, Härtl. Administrative/technical/material support: Härtl.

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