Traumatic Brain Injury in a Rural and an Urban Tanzanian Hospital—A Comparative, Retrospective Analysis Based on Computed Tomography

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■ BACKGROUND: **In a resource-poor environment such as rural East Africa, expensive medical devices such as computed tomographic (CT) scanners are rare. The CT scanner at the rural Haydom Lutheran Hospital (HLH) in Tanzania therefore offers a unique chance to observe possible differences with urban medical centers in the disease pattern of trauma-related cranial pathologies. The purpose of this study was to compare traumatic brain injuries (TBIs) between a rural and an urban area of Tanzania.**

■ METHODS: **HLH has 350 beds and one CT scanner. The urban Aga Khan Hospital is a private hospital with 80 beds and one CT scanner. This was a retrospective study. Data of 248 patients at HLH and of 432 patients at Aga Khan Hospital with TBI could be collected.**

■ RESULTS: **The prevalence of TBI was significantly higher in the rural area compared to the urban area (34.2% vs. 21.9%, $P < 0.0001$). TBI due to violence was noted to occur more frequently at HLH, whereas road traffic accidents were more frequent at the Aga Khan Hospital. The number of patients showing a normal CT result was significantly higher in the urban area (53.0% vs. 35.9%, $P < 0.0001$). Bone fractures (35.9% vs. 15.7%, $P < 0.0001$) and pneumocephalus (6.9% vs. 0.9%, $P < 0.0001$) were diagnosed significantly more frequently in the rural survey. Soft tissue swelling (11.6% vs. 1.2%, $P < 0.0001$) and frontal sinus injuries (7.4% vs. 0.4%, $P < 0.0001$) were observed significantly more often in the urban setting.**

■ CONCLUSIONS: **This study documents the burden of TBI and the differences in TBI-related CT diagnoses and their incidence between urban and rural areas in Eastern Africa. These results are important as they demonstrate that patients with severe TBI are not a primarily urban concern. Management of TBI should be included in the training curricula for health personnel alike irrespective of whether their workplace is primarily urban or rural.**

Sub-Saharan Africa severely lacks specialists in both neurology and neurological surgery. These demands are in addition to the lack of the corresponding technical infrastructure, which includes but is not limited to the two fundamental imaging modalities in modern medicine: magnetic resonance and computed tomographic (CT) imaging. The World Health Organization indicated in 2004 a median ratio of only 0.01 neurologic surgeons per 100,000 inhabitants in Africa. This ratio is considerably higher in the Americas (0.76) and Europe (1.02). The trends are very similar with respect to neurologists, neurologic imaging, and diagnostic techniques (19, 23); in fact, according to the World Health Organization, up to 81.2% of all African countries have limited or no access to neuroimaging modalities, which represents a serious medical concern (23). Consequently, only few neurologic interventions are performed and only limited data exist about cranial and spinal pathologies in Africa (3, 6, 8, 21).

Key words
- Africa
- Brain
- Computed tomography
- Epidemiology
- Radiography
- Rural population
- Tanzania
- Traumatic brain injury

Abbreviations and Acronyms
AKH: Aga Khan Hospital
CCT: Cranial computed tomography
CT: Computed tomography
HLH: Haydom Lutheran Hospital
MRI: Magnetic resonance imaging
TBI: Traumatic brain injury

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Most CT scanners are located in urban areas and data on neurologic disease in rural areas is relatively scarce. Traumatic brain injury (TBI) contributes to substantial disease burden in sub-Saharan Africa, with resulting high morbidity and mortality (21, 22), and therefore is of major public health concern. To date, there are no systematic data on clinical findings and imaging results in patients with TBI in sub-Saharan Africa, which is thought of paramount importance to allocate medical and surgical resources. We therefore collected data on clinical and imaging aspects of TBI from both an urban and rural catchment area in Tanzania and compared our findings in the two centers.

METHODS

Study Sites

The Haydom Lutheran Hospital (HLH) was founded in 1954. The hospital was initially able to hold 50 beds but has since expanded to 350 beds (1) in 2009. Despite this increase, the inpatient care unit provides care to more than 400 patients at any given time because of the shortage of medical facilities in the area; it is now officially regarded as a referral center (2) with approximately 390,000 people inhabiting the surrounding areas. The institution's CT scanner started functioning in January 2005, which now allows for the systematic method of archiving acquired images with corresponding medical records. Patients seen at HLH are required to pay financial contributions towards treatment. However, in cases of insufficient financial ability, patients are still able to receive necessary treatment. Neurologic and neurosurgical services are, however, not continuously available. Rather, they are provided by visiting consultants through organizations such as the *African Medical and Research Foundation* or by foreign volunteering surgeons serving for a brief period of time. Nevertheless, the resident general surgeons of HLH are trained to perform certain neurosurgical interventions (4).

In contrast, the Aga Khan Hospital (AKH) is a private Hospital in Dar es Salaam and is run by the nonprofit Aga Khan Foundation. It was built in 1964 and has a capacity of 80 beds. The hospital provides several medical specialist services, including radiology, but no neurologic surgery. Neurosurgical services in Dar es Salaam are offered only by the public Muhimbili hospital. CT imaging at AKH was introduced in 2003, followed by magnetic resonance imaging (MRI) in 2005. The hospital's archive provides data from patients undergoing neuroimaging since then. At the time of data collection, Aga Khan's MRI scanner was the only one in Tanzania. Even though the urban hospital is run by a nonprofit organization, the institution requires patients to completely cover the financial burden for treatment.

Analysis

All CT and MRI records were retrieved in order to obtain a comprehensive list of all patients who had undergone cranial imaging. Cranial CT (CCT) images at HLH were reviewed from January 2005 to June 2008. Similarly, CCT-derived data at AKH were reviewed from January 2003 to September 2007; cranial MRI–related data were reviewed from September 2004 to October 2007.

Gender, age, diagnosis, and the medical history were recorded. To avoid selection bias, 212 cases at HLH were excluded from the current analysis as these patients had undergone CCT scanning for research purposes concerning epilepsy and neurocysticercosis (20).

The scans had been assessed by local radiologists in the respective hospitals. In 209 cases of missing or nonconclusive radiologic diagnosis at HLH, a board-certified neuro-intensivist from Innsbruck, Austria, reassessed the images for a definitive diagnosis prior to analysis.

Seven hundred twenty-six patients undergoing CCT from the rural catchment area (HLH) were included in the initial assessment. Of these, 248 patients were hospitalized because of TBI. At the urban area (AKH), data from 1975 CCT and 537 MRI patients were reviewed. Of the 1,975 CT-evaluated patients, 432 patients were diagnosed with TBI. There were only two patients out of 537 undergoing MRI because of recent trauma. Consequently, the MRI cohort was excluded from the analysis concerning TBI.

For frequency comparisons of categorical values, the χ^2 test was used. For comparison of mean values, a *t* test was performed. All

Table 1. Demographics of the Study Populations Undergoing Cranial Computed Tomography Due to Head Trauma

	AKH	HLH	*P* Value
Overall study population	1975	726	
Number of head trauma patients	432	248	
% overall study populations	21.9%	34.2%	< 0.0001†
Male-to-female ratio	2.12:1	5.68:1	< 0.0001*
Mean age (years)	40.5	33.7	< 0.0001†
Median age (years)	41.0	29.0	
SD (years)	19.7	19.8	
Age range	2 months—84 years	3 months—100 years	

AKH, Aga Khan Hospital; HLH, Haydom Lutheran Hospital; SD, standard deviation.
*χ^2 test.
†*t* test.

Table 2. Mechanism of Traumatic Brain Injury

	AKH		HLH		
Mechanism of TBI	Number of Patients	Percentage	Number of Patients	Percentage	*P* Value (*t* Test)
Road traffic accident	200	46.3	63	25.4	< 0.0001
Other causes	120	27.8	54	21.8	0.0849
Unknown cause	79	18.3	53	21.4	0.3257
Crime	33	7.6	78	31.5	< 0.0001
Total	432	100.0	248	100.0	

AKH, Aga Khan Hospital; HLH, Haydom Lutheran Hospital; TBI, traumatic brain injury.