Chapter 14
Review of Reasons for Patients to Receive a CT of the Head and Neck Region in Uganda in 2011–2012

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Abstract This paper describes the reasons for 403 patients to receive a CT-scan of their head and neck in the Department of Radiology of the Mulago Hospital in Kampala Uganda in 2011–2012. The objective of this study was to determine the indications for this imaging investigation and the total percentage of patients with each indication. The study undertook to answer these three major questions: 1) Which were the most common indications for a CT-Brain scan? 2) Was there a gender difference in the imaged patients? 3) Were there age differences in each category of the imaged patients?

We examined 403 cases and noted these 16 different indications for Brain CT scans:

Head Trauma, Cerebral Vascular Accident (CVA), Space Occupying Lesion (SOL), Head Symptoms, Brain Tumors, Cryptococcus/Toxoplasmosis/HIV Meningitis, Headache, Seizures, Spinal Symptoms, Facial Injury, Dementia, Congenital Anomalies, Follow up, Psychiatric indications, Encephalitis and Loss of Consciousness (LOC). For each category we included the number of cases with the gender and age of the patient being imaged.

Head trauma and especially from Road Traffic Accidents (RTA) was the most common indication for a Brain CT-scan request forming 48 % of the cases.

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The many Road Traffic Accidents, 48% of the cases, were due to the presence of small motor bike taxis called “boda-boda”. CVA were the second most common indications forming 11 %. Combined, RTA and general trauma to the head form a major burden on the country.

In terms of gender, for the 403 cases we reviewed 277 (69 %) were males while 126 (31 %) females. In all categories of trauma generally, more males than females were affected and this was especially more so in RTA cases where 119 males and only 35 females were imaged. In the cases of assault, more males (32) than females (4) were affected, and finally in cases of trauma due to a fall again more males (9) than females (4) were affected. The few elderly patients (those above 60) that were seen with dementia were primarily females. As for age, in each category, there were more young males (age-bracket 14–44 years) than females. Still this was more evident in the cases of Trauma and CVA.

Keywords CT-scan images • Cerebro-vascular accidents (CVA) • Dementia • Gender • Road traffic accidents (RTA) • Trauma • Traumatic brain injury

Abbreviations

Boda-boda	Small ubiquitous motor cycle taxis
CHI	Closed head injuries
y.o.	Years old
CT-scan	Computer tomography scan
CVA	Cerebrovascular accidents
HIV/AIDS	Human immunodeficiency virus/acquired immunodeficiency syndrome
NCD	Non-Communicable Disease
OHI	Open head injuries
RTA	Road Traffic Accidents
SOL	Space Occupying Lesions
TBI	Traumatic Brain Injury

Introduction

This paper describes the reasons for patients receiving a CT-scan image of their head-neck region in 2011 and 2012 in the Department of Radiology of the Mulago Hospital Complex in Kampala, Uganda. Mulago Hospital in Kampala is the major national referral hospital in the country. It has a bed capacity of over 1,700 but at times the numbers of inpatients are more than the available beds hence creating floor cases. The government allocation to the health sector is on average 9.6 % of the total government budget (GOU 2010) with the hospital consuming approximately 12 % [5] of the national health budget.

The objectives of this study were to determine:

1. Which were the most common indications for a head and neck CT-scan at Mulago Hospital?
2. Was there a gender difference in the imaged patients?
3. Were there age differences in each category of the imaged patients?

Materials and Methods

Collection of Cases

Every year there are over 7,200 CT-scan studies of the Head-Neck region made in the Department of Radiology of Mulago Hospital. The majority of these cases are due to trauma from road traffic accidents, RTA.The vast majority of these records are currently in the form of paper charts or files. With the aid of the staff in the Department of Radiology, charts were collected from 2011–2012 for 403 patients. These charts were selected at random and were then scanned digitized, and analyzed they formed the basis of this study.

Prior to imaging all the patients were given a physical examination including a neurological examination. When there were abnormalities present they had a CT-scan and then an analysis of their images with a clinical diagnosis. The diagnosis listed for each patient was performed by the radiologists of the Department of Radiology in Mulago Hospital.

CT-Scan Analysis

All the patients in this study had a CT image only after abnormalities were found on their physical or neurological examination. All the CT images were obtained on a MX 16 Philips CT Scanner acquired in August 2010.

Image Reconstruction

The DICOM images that were collected by the Philips CT Scanner were reconstructed to demonstrate 3D features were analyzed on a 4 channel Mac Pro running Leopard 10.5 and 3D reconstructions were made using OsiriX 5.0.

Results

For this study we reviewed the digitized file charts from 403 patients and we found the indications to be 16 different categories which are discussed below and are listed in Table 14.1 and Fig. 14.1. The 16 different categories were arranged in frequency of imaging as follows: Head Trauma, Cerebral Vascular Accidents (CVA), Space Occupying Lesion (SOL), Head Symptoms, Tumors, Spinal Symptoms,

Table 14.1 List of reasons (indications) for patients to undergo CT-brain scans at Mulago Hospital, Kampala

Reason	Total #	Subclass	#
Trauma	**195**	**RTA: Boda-Boda 135, Auto 19.**	**154**
		Normal	14
		Assault	**28**
		Fall	**13**
CVA	**46**	**Ischemic**	15
		Hemorrhagic:	28
		(Subdural	10
		Epidural	2
		Intracranial	13
		Interventricular)	3
		Normal	3
Exclude SOL (space occupying lesion)	**33**		
Head symptoms	**24**	**Ear**	5
		Mouth	1
		Nasal	3
		Optic	14
		Skull	1
Tumor	**19**	**Neural**	5
		Non-neural	14
Seizure	**12**		
Toxoplasmosis/HIV	**12**		
Headache	**12**		
Spinal symptoms	**10**		
Facial injury	**10**	**Trauma**	5
		Palsy	4
		Tumor	1
Dementia	**8**		
Congenital abnormalities	**7**		
Follow up	**5**		
Psychiatric disorders	**4**		
Encephalitis	**3**		
LOC (loss of consciousness)	**3**		
Grand total	**403**		

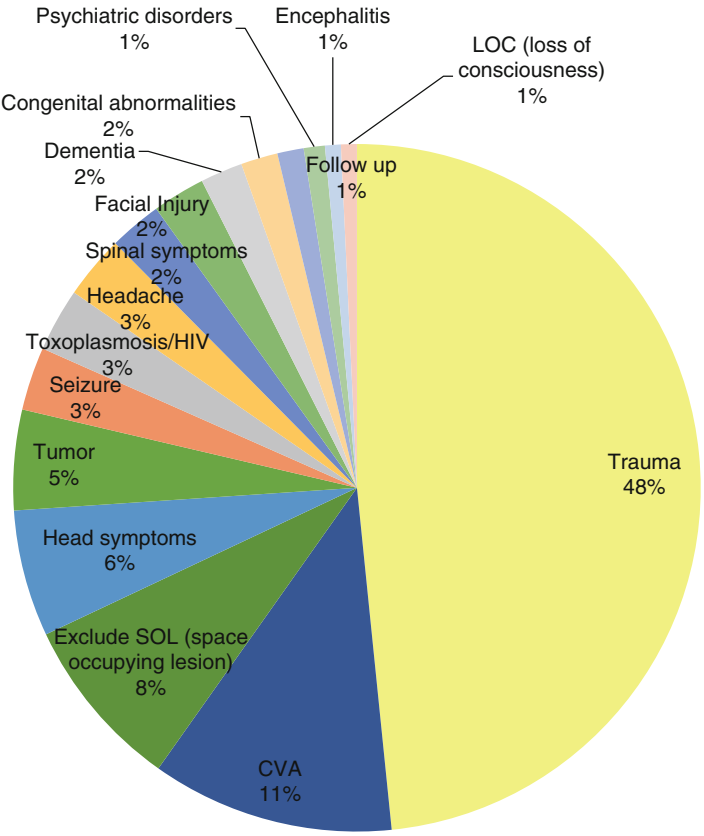
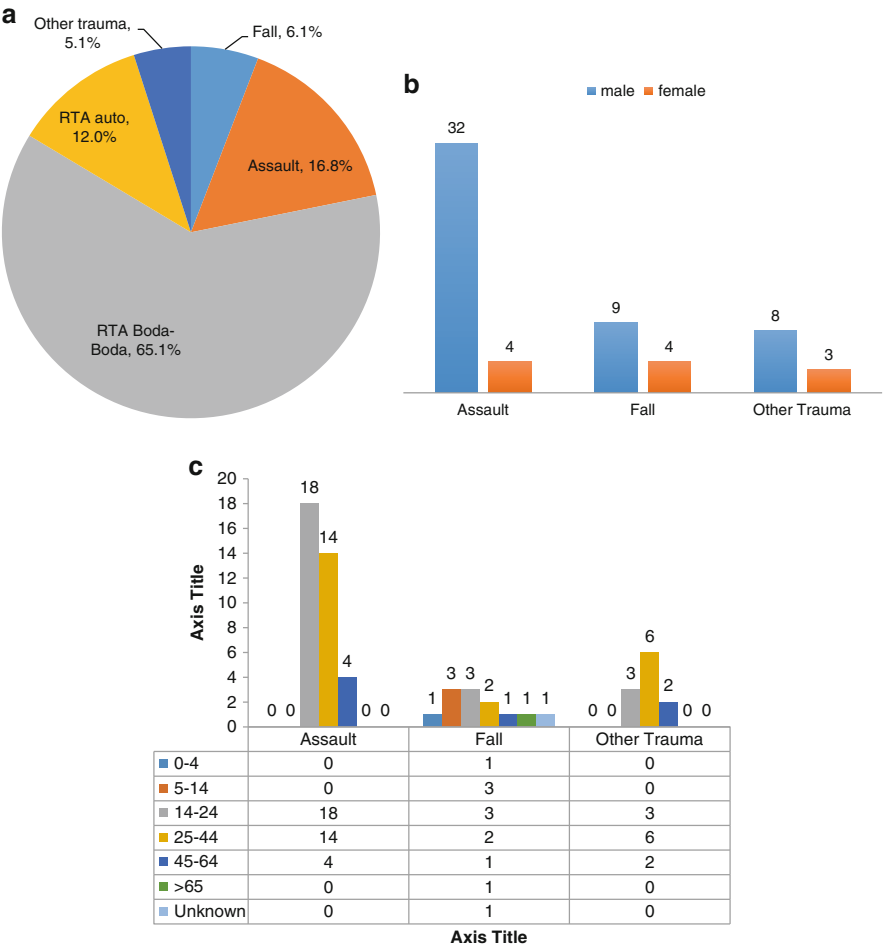


Fig. 14.1 Pie Chart demonstrating

Cryptococcus/Toxoplasmosis/HIV meningitis, Headache, Seizures, Facial Injury, Dementia, Congenital Anomalies, Follow up, Psychiatric indications, Encephalitis and Loss of Consciousness (LOC). In each category we also included the number of cases with the gender and age of the patient being imaged.

What Where the Most Common Indications That Required a Head-Neck CT-scan? (Fig. 14.2)

We found the majority of the indications were due to Trauma which involved 48 % of the cases followed by Cerebrovascular accidents, CVAs, as the next most common indications affecting 11 % of the cases.



	Assault	Fall	Other Trauma
0-4	0	1	0
5-14	0	3	0
14-24	18	3	3
25-44	14	2	6
45-64	4	1	2
>65	0	1	0
Unknown	0	1	0

Fig. 14.2 (**a**) Trauma subclasses; (**b**) gender distribution of trauma subclasses; (**c**) age distribution of trauma subclasses

Head Trauma (Fig. 14.2)

We identified a total of 197 patients that were imaged due to a traumatic incident and in this category abnormalities were noted in CT-scans from 154 cases of road traffic accidents, RTAs, 28 cases of Assault and 15 cases due to a fall.

Road Traffic Accidents or RTAs, (Fig. 14.2a), formed 77 % of the total cases of head trauma. There were 154 cases of trauma due to RTA with 10 % (14 cases), demonstrating no abnormalities in their CT head scans. The vehicles that were

involved in these accidents were in 12 % (19 of the cases) due to accidents in automobiles or trucks while the majority, 88 % (135 patients) were due to accidents on the small ubiquitous motor bike taxis called "boda-boda" in Uganda (Table 14.1).

Traumatic Brain Injuries (TBI)

Of the 154 patients with trauma from RTA, 89 % had traumatic brain injuries, TBI, while 61 % of the imaged patients due to assaults and falls had TBI. In the RTA sub-category, males were more commonly affected with 119 males vs. 34 females (Fig. 14.3a) and the most common ages of the affected were in the 14–44 year age bracket (Fig. 14.3b).

In Fig. 14.3c in the RTA category we noted that the patients that were imaged due to head injuries consisted of 47.2 % with closed head injuries (CHI), and 37.7 % with open head injuries. All the patients that had either open or closed head injuries had neurological deficits. Of the patients admitted for evaluation of head injuries, 14 % were found to have no abnormalities in their head CT-scan images.

Trauma Due to Either Assault or a Fall (Fig. 14.2a–c)

The other common causes of trauma which led to a patient being imaged included 28 cases of Assaults and this formed 13 % of the cases of trauma, and 13 (6 %) were cases of Falls with 10 % of these cases showing no abnormality in their CT-scan images. These assault and fall injuries were more common in males in 49 cases vs. 11 in females There were another 10 cases listed with 5 of them having brain edema from many sources including infections. The remaining 5 cases were from other forms of unspecified causes and these were all without any abnormalities in their CT-scan images.

Imagery of Skull Fractures from RTA

Figure 14.3d–h, are examples of skull fractures seen in several of the patients caused by RTAs.

Figure 14.3d, CT-brain scan of RTA: Fracture of Frontal Bone in male age 24 with headaches following RTA.

Figure 14.3e. Case of RTA. 3D reconstruction of fracture of frontal bone shown in Fig. 14.3d of a male age 24. OsiriX Open Source imaging Software version 5.9.

Figure 14.3f. Case of RTA. 3D reconstruction of a fracture of left Occipital bone in male age 14 with headaches following RTA. OsiriX Open Source imaging Software version 5.9.

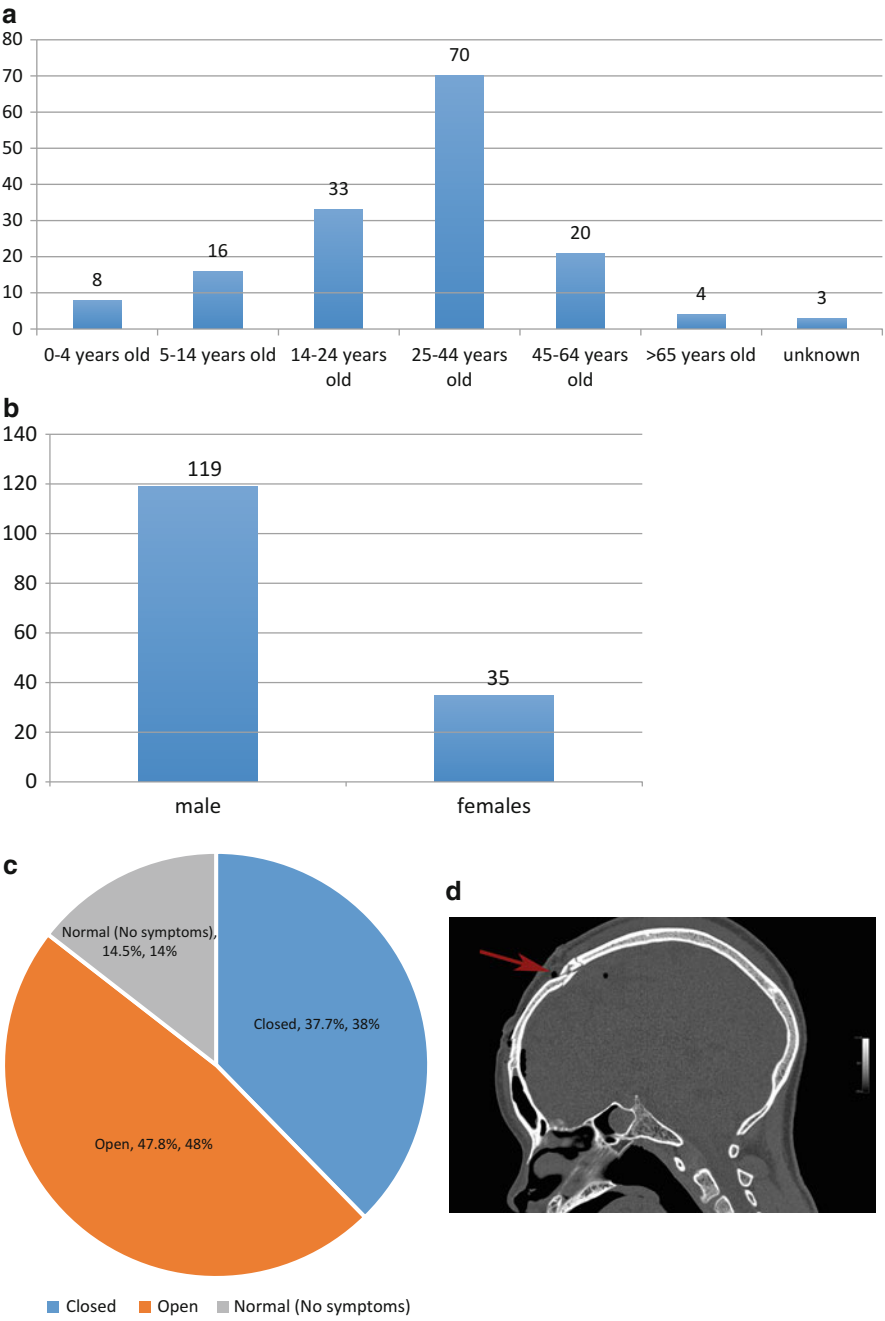


Fig. 14.3 (**a**) RTA head injury age demographic by age; (**b**) RTA head injury gender demographic; (**c**) RTA head injuries open head injuries vs. closed head injuries; (**d**) CT, sagittal image, fracture of frontal bone, *red arrows*, after RTA, male age 24 with headaches, *red arrow*; (**e**) 3D reconstruction of skull shown in (**d**) with fracture of frontal bone, *red arrows*, in a male age 24 (OsiriX imaging Software version 5.9); (**f**) RTA 3D reconstruction of a skull with a fracture, *red arrow*, of left occipital bone in male age 14 with headaches (OsiriX imaging Software version 5.9);

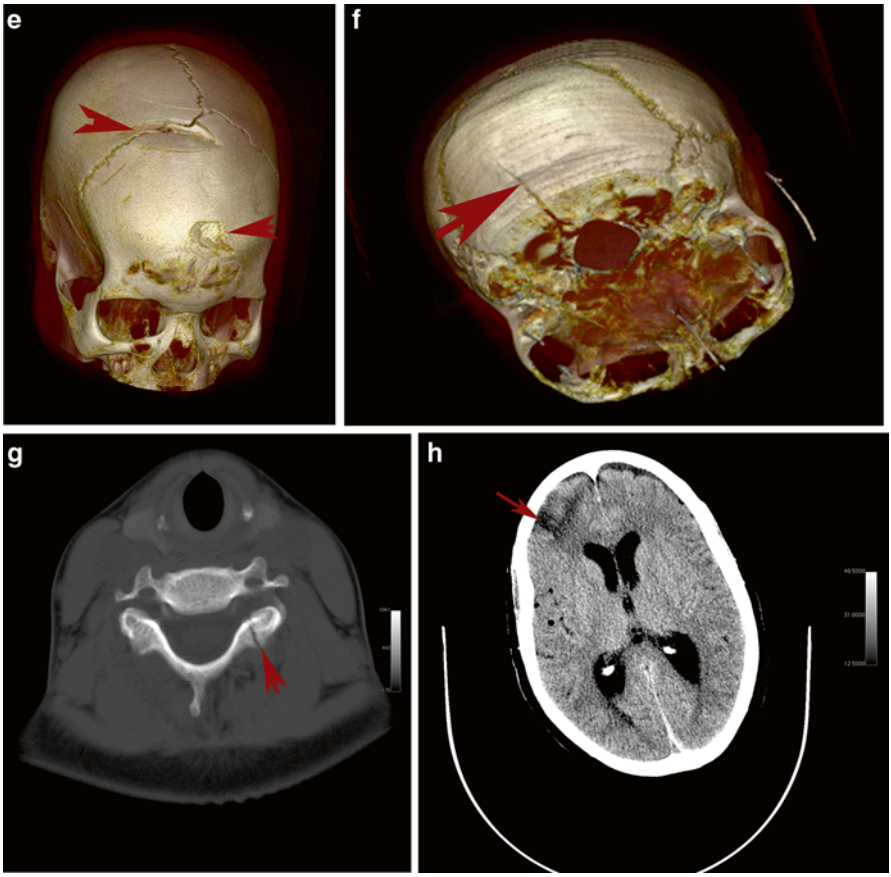


Fig. 14.3 (continued) (**g**) RTA CT fracture of left lamina, *red arrow*, in cervical vertebrae C2 male age 19 with pain and some muscular symptoms; (**h**) RTA. CT image demonstrating the effects of an intracerebral contusion to the right frontal polar cortex due to a RTA in a 64 year old female. The patient demonstrated some changes in personality and upper motor neuron signs on the left side of the body

Cerebrovascular Accidents (CVA)

Table 14.1 lists cerebrovascular accidents, CVA, as the second most common indication for imaging after trauma forming 46 (11 %) of the total imaged cases. In the CVA category 43 cases (93 %) had significant cerebral lesions upon examination of their CT-scan images as a consequence of the CVA. Only 6.5 % of these cases had no abnormalities in their CT images or in their neurological examination.

The types of CVA as noted in Fig. 14.4a were 68 % hemorrhagic and 32 % ischemic.

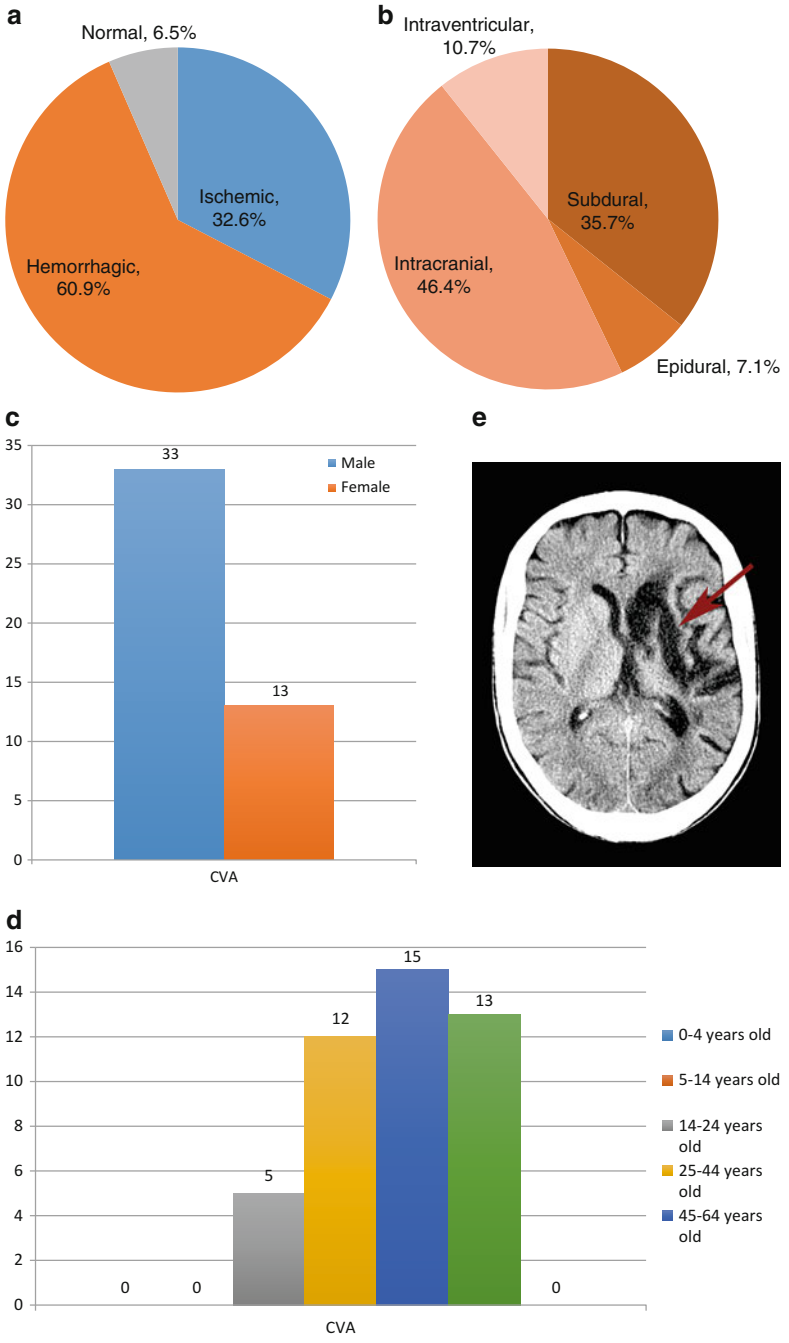


Fig. 14.4 (**a**) CVA. The types of CVA were 68 % hemorrhagic and 32 % ischemic; (**b**) CVA. The locations of the 28 cases with hemorrhagic lesions were divided as follows: epidural 2/7 %, subdural 10/35 %, intraventricular 3/10.7 %, and intracranial 13/46.4 %; (**c**) Gender of patients with CVA. They were more common in males with 33 while 13 females affected; (**d**) Age of patients with CVA. The ages affected were primarily from 14–64 y.o; (**e**) This is a CT from a 60 year old male patient with a CVA in the distribution of the inferior branch of the left MCA with an infarct into the left Inferior Frontal Gyrus and Insular cortex, *red arrow*, with Broca's motor aphasia and upper motor neuron symptoms in the right arm

The locations of the 28 cases with hemorrhagic lesions as shown in Fig. 14.4b were divided as follows: epidural 2 (7 %), subdural 10 (35 %), intraventricular 3 (10.7 %), and intracranial 13 (46.4 %). The cases with ischemic lesions were located throughout the brain.

The CVAs were more common in males with 33 with 13 being females (Fig. 14.4c).

The most commonly affected ages, as noted in Fig. 14.4d, were from 14 to 64 y.o.

Figure 14.4e is a CT-head scan from a 60 year old male patient with a CVA in the distribution of the inferior branch of the left MCA with an infarct into the left Inferior Frontal Gyrus and insular cortex with Broca's motor aphasia and upper motor neuron symptoms in the right arm.

Space Occupying Lesions (SOL): Table 14.1 and Fig. 14.1

There were 33 cases (8 %) of the total imaged cases that were due to suspected space occupying lesions. In this category there were 17 females and 16 males, a 1:1 ratio in the affected.

Head Symptoms: Table 14.1 and Fig. 14.1

There were 24 cases, with 5 cases (6 %) of the total having involvement of the ear; 5 cases mouth; 3 cases nose; 3 cases, eyes; 14 cases skull, One of Six of the cases associated with the eye had some neurological signs including double vision and pupillary signs while the other cases were within normal limits. In this category there were 14 males and 10 females affected.

Brain Tumors (Table 14.1 and Fig. 14.1)

There were 19 cases with brain tumors forming, 5 % of the total cases. In this group there were 5 intracranial cases and, 14 with non-intracranial involvement. The 5 cases with intracranial tumors exhibited abnormal neurological signs. In this category there were 10 males and 9 females affected.

Seizures, Cryptococcus/Toxoplasmosis/HIV, and Headache

In this category there were 12 cases being 3 % of the total, as shown in Table 14.1 and Fig. 14.1. The seizures were either a consequence of a RTA, CVA or HIV. The Cryptococcus/Toxoplasmosis/HIV cases were noted in patients who were either

not responding to the antiretroviral treatment or not taking their medicines regularly. There was an equal number of males and females affected with 6 of each gender.

Spinal Symptoms

In the category of spinal symptoms, there were 10 cases, being 2 % (Table 14.1 and Fig. 14.1). The spinal symptoms were associated with RTA (Fig. 14.3g). There were more cases of spinal cord injuries in males than females: 7 cases to 3.

Facial Injuries

Facial injuries were noted in 10 cases being 2 % of the total (Table 14.1 and Fig. 14.1). There were 5 facial injuries due to trauma and 4 palsies with two of these cases being of Bell's palsy, and 1 due to a facial tumor. Facial injuries were more common in males than females 6 to 4.

Dementia

A referral for dementia was noted in 8 cases or 2 % of the total cases (Table 14.1 and Fig. 14.1) with 7 females and 1 male. The cases of dementia were in elderly patents being over 60 with 7 being females and one male. in the general population in Uganda the elderly are reported to be 4–6 % [5].

Congenital Anomalies

Congenital anomalies formed 7 cases, being 2 %, (Table 14.1 and Fig. 14.1). One case included a Siamese twin. There were 4 males and 3 females.

Follow Ups

Patients that were referred back for follow up CT images formed 1 %, with all 5 cases being due to RTA (Table 14.1 and Fig. 14.1). In the follow ups there were 3 males and 2 females.

Psychiatric Disorders

Referrals from Psychiatric illnesses formed 4 cases, 1 % of the total (Table 14.1 and Fig. 14.1). There were 2 males and females that were imaged.

Encephalitis

Encephalitis was noted in 3 cases all related to malaria, 1 % (Table 14.1 and Fig. 14.1).

Loss of Consciousness

Loss of Consciousness, LOC, formed 3 cases, 1 % of total. They were related in two cases to Trauma and one case to a CVA (Table 14.1 and Fig. 14.1).

Were There Gender Differences in Each Category?

In the 403 cases we reviewed 277 were in males and only 126 in females giving a Male:Female ratio of 9:5 or 1.8:1. In all categories of trauma, more males were affected. In RTA cases more males were affected than females; 119 and 35, respectively (Fig. 14.3b). In assault cases, also more males were affected than females; 32 and 4 respectively (Fig. 14.2c). Finally in cases of trauma due to a fall, again more males than females were affected; 9 vs. 4 respectively (Fig. 14.2c). In the other cases of trauma, these were also more common in males than females; 8 vs. 3 respectively (Fig. 14.5b).

In CVAs (Table 14.1 and Fig. 14.4c), of the 46 cases 33 (71 %) were in males and 13 (29 %) were in females. There were also 3 cases (2 males and 1 female) that were imaged for a CVA but the images were within normal limits.

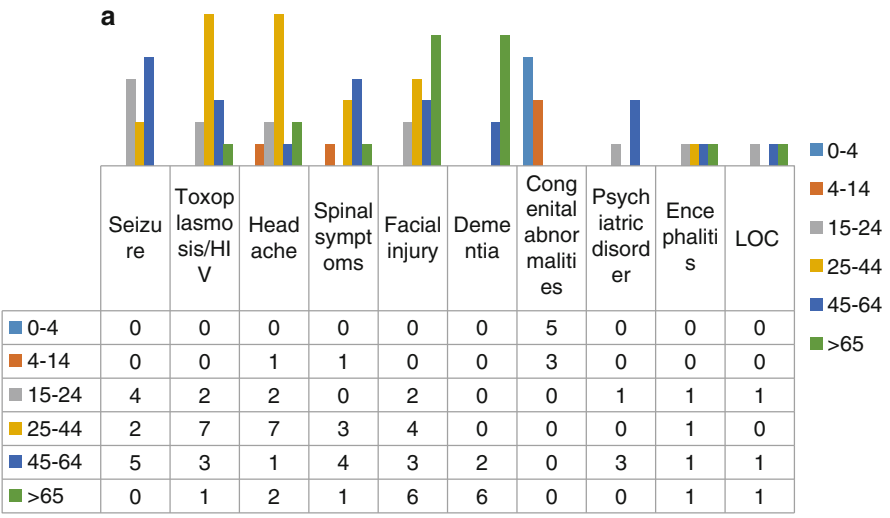
Congenital abnormalities were noted in 5 females and 2 males (Fig. 14.4c).

Dementia was noted in only 8 cases (Fig. 14.5b). In the patients who were screened for dementia there were 7 females and 1 male.

Were There Age Differences in Patients in Each Category? (Figs. 14.3a, d, and 14.5a)

Trauma In all categories more younger males were affected as evidenced in the RTA, assaults and falls (Fig. 14.3a) from ages 14–44 y.o.

a



	Seizure	Toxoplasmosis/HIV	Headache	Spinal symptoms	Facial injury	Dementia	Congenital abnormalities	Psychiatric disorder	Encephalitis	LOC
0-4	0	0	0	0	0	0	5	0	0	0
4-14	0	0	1	1	0	0	3	0	0	0
15-24	4	2	2	0	2	0	0	1	1	1
25-44	2	7	7	3	4	0	0	0	1	0
45-64	5	3	1	4	3	2	0	3	1	1
>65	0	1	2	1	6	6	0	0	1	1

b

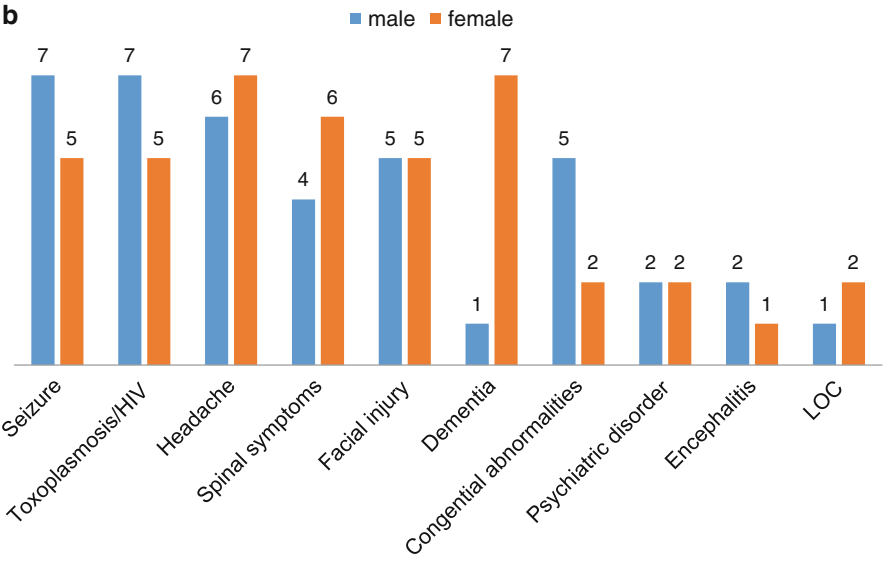


Fig. 14.5 (**a**) Age distribution of other maladies imaged; (**b**) gender distribution of other maladies imaged

In CVAs (Fig. 14.4d), the age range was 14–64+ and more males were affected with the majority being from age 25–64+.

Dementia Cases formed only 8 cases, 1 male and 7 females. The patients ranged in age from 60 and older (Fig. 14.5a).

Discussion

Non-Communicative Diseases

In another paper in this book [4] we noted the similarity seen in the percent of neurodegenerative, non-communicative diseases of the brain seen in Africa and in the United States and Europe due to our common origin out of Africa many thousand years ago [9]. However, since occurrence of these migrations millenia ago, many environmental factors have since influenced the non-communicable disease process in the central nervous system and especially the resultant extension in the life cycles in the higher income regions of the world. In these higher income regions there are many positive improvements in public health, but also a major increase in the presence of many cases of neurodegenerative disease and especially Alzheimer's' disease as the population ages. In Uganda which is a lower income region, the vast majority of the 403 records that were reviewed were of patients of less than 50 years of age.

Dementia, in our study only constituted 8 of 403 (2 %) patients that were imaged. They were all over 60 years in age with 7 of the 8 (87.5 %) being female. In a study in Tanzania, Mavrodaris, Powell and Thorogood [8] noted that there was a major problem in accurate data collecting in the sub-Saharan African region as there were only a few electronic data bases. When more data base will be formed one should have a more accurate and complete insight on the amount of age-related dementia in the region. Paddick et al. [10] observed that dementia and other non-communicative diseases will become an increasing burden on health services in Sub-Saharan Africa as the NCD population ages due to the control of the communicative disease of malaria, HIV/AIDS and TB [7].

Communicable Diseases

Currently malaria is the leading cause of illness (morbidity and mortality) in all communicable diseases in these regions (CDC and WHO 2013). In our 403 cases there were only 12 patients imaged for malaria and for HIV AIDS. Even though there are still too many cases of malaria and HIV/AIDS in Uganda most of these cases are diagnosed without CT-scan imagery. UNICEF has shown encouraging results in the reduction in the number of children, with cases of malaria, HIV/AIDS and malnutrition. However, there are still too many people that are affected by these diseases (WHO 2012).

Trauma

In regard to Trauma, in this review of the patients undergoing a CT-head scans, 195 of the 403 (48 %) of the patients were imaged due to trauma (Table 14.1 and Fig. 14.1) males aged 14–44 years were most commonly affected (Figs. 14.2c, 14.3b, 14.4c,

and 14.5b). For the RTA, a major difference is noted in the vehicles involved in the countries with higher income than in countries with lower incomes. In the higher income regions the accidents are primarily in automobiles while in lower income countries including Uganda the accidents are primarily with the smaller motor cycles called "boda-boda" which offer the riders very little protection [15]. These small motor bikes are widely used throughout East Africa and in many of the lower income countries such as India and Bangladesh [6, 11]). The results of our study confirm the burden placed on Uganda by the many cases of trauma, the vast majority of which are due to accidents on these small motor bikes, the "boda-bodas".

Traumatic Brain Injury (TBI)

In our study TBI was caused by RTA, falls, and accidents. The data from the WHO [15] and the World Bank [13], shows that RTAs are the leading cause of TBI in the world [15]. TBI are the leading cause of death and disability in children and young adults in the world and they cause about half of the deaths that result from trauma [16].

The data from the World Health Organization and the World Bank [13] also notes that RTA injuries cause considerable economic losses to the victims, their families, and to nations as a whole. These losses arise from the cost of treatment (including rehabilitation) as well as lost productivity (e.g. in wages) for those killed or disabled by their injuries, and for family members who need to take time off work (or school) to care for the injured.

About 1.2 million people die worldwide each year as a result of road traffic accidents [15] with road traffic injuries the leading cause of death among young people, aged 15–29 years and more males than females are affected.

Road Traffic Accidents (RTA) cause 91 % of the world's traffic fatalities and these mostly occur on the roads of low-income and middle-income countries, even though these countries have approximately only half of the world's vehicles [13]. Only 28 countries in the world, from the higher income regions of the world representing 416 million people and they contain less than 10 % of the world's current population. These high income countries have laws that address all five of the risk factors involved in RTA – speed, drink-driving, helmets, seat-belts and child restraints [3]. Uganda with a rate of 28.9 deaths per million due to the numerous RTA is in the top percentile of the world's deaths caused by RTAs [12] (WHO and World Bank 2014). As we noted in our study RTA formed the bulk of the patients imaged. Over 90 % of these cases had TBI, (Fig. 14.2b). One shouldn't be surprised that the CT facilities are nearly overwhelmed by these accidents.

*Cerebro-Vascular Accidents (*CVAs*)*

Table 14.1 and Fig. 14.1 lists CVAs as the next most common cause for CT brain imaging after trauma forming 46 or 11 % of the total cases. Only 3 or 7 % of the CVA cases had no abnormalities in their CT-scan images or on their neurological

examination. In the other 43 cases with CVAs, in 93 %, there was TBI in their CT-scan images. The lesions as noted in Fig. 14.4a were 67 % hemorrhagic and 33 % ischemic. The 28 cases with hemorrhagic lesions, (Fig. 14.4b), were divided as follows: epidural 2(7 %), subdural 10(35 %), interventricular 3(10.7 %), and intracranial 13(46.4 %). The CVAs were more common in males, 33 cases vs. only 15 females cases affected, (Fig. 14.4c).The need for prevention of stroke and especially the control of hypertension has been noted in Sub-Saharan Africa by Chin [2] and Addo, Smeeth and Leon [1], and there have been improvements noted [14].

Much progress has been made in the treatment of malnutrition and in malaria prevention by adding mosquito netting as well as in the prevention of HIV/AIDS [14]. However NCD such as hypertension and the RTA with its deleterious consequences have not yet been addressed in most lower income countries. In our review of the 403 patients undergoing a CT head scans, 197 trauma cases were imaged (Fig. 14.2a) and 154 of the trauma cases were due to Road Traffic Accidents with 89 % of the RTA cases demonstrating TBI. In the total number of 154 RTAs, 135 or 88 % were due to accidents on the small motor bikes (boda-boda) with only 12 % as result of automobile or truck accidents (Table 14.1).

How Does One Counteract the Many Deleterious Effects of the RTA Due to the Ubiquitous Small Motor Bikes the Boda-Bodas?

The reality is that in Kampala, motor bikes or boda-boda taxis, since their introduction in the 1990s, do provide jobs and plug the gaping holes in the public transport system. They have become ubiquitous and indispensable with frequent accidents which often are deadly [6, 11]. In Kampala there are fleets of these two-wheeled motor cycles and no one knows exactly how many there are, but the local media reports that there may be as many as 300,000 boda-bodas on the streets of the Ugandan capital, always on the lookout for passengers [6, 11]. The City of Kampala has recently begun to address this problem by expanding its public transport with the acquisition of buses, and there have been progress in better training the drivers of these motorcycles. However driving and riding boda-bodas is an easy means to get around the city and also provides many jobs in a country with high unemployment [6]. One method that is being championed and could lead to a great reduction in frequency and the consequences of RTA is The Global Helmet Vaccine Initiative [3]. This Initiative which has not yet caught on, offers much promise for the future as it is trying to train drivers how to drive safely, and also convince them and their patrons to purchase and to wear helmets. This is an effort to stop the occurrence of so many TBI without banning bikes altogether.

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