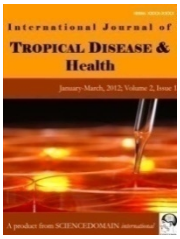

International Journal of TROPICAL DISEASE & Health
4(2): 233-243, 2014

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288 Pioneer Computed Tomographic Examinations in University of Uyo Teaching Hospital, Uyo, Nigeria

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Authors' contributions

This work was done in collaboration with all authors. Author UUF conceived and designed the study. Authors UUF, UED and VOJ wrote the protocol and the first draft of the manuscript. Authors UUF and author VOJ collected the data. Authors UUF, UED and VOJ managed the analysis, literature searches and Tables/Figs. All authors revised and approved final manuscript.

Original Research Article

Received 31st August 2013
Accepted 11th November 2013
Published 13th December 2013

ABSTRACT

Background: Computed tomography (CT) is a cross sectional imaging tool that has dramatically improved diagnosis. Its increasing availability was recently extended to University of Uyo teaching hospital (UUTH), Uyo, Nigeria.
Aim: Evaluating pioneer CT examinations in UUTH, Uyo.
Materials and Methods: A retrospective study of all CT examinations conducted after the installation of the 16 slice Activion Toshiba, 2009 CT scanner. Period studied was from 4th November, 2012 to 9th August, 2013. Some CT scans were done with intravenous contrast with/without oral contrast. Demographic data, clinical presentations, type of examination and positive radiological features were extracted from records of all computed tomograms.
Results were analysed with SSPS 13 computer package.
Results: 288 Patients were studied but 281 with adequate demographic data were analyzed. Of this number, 56.6% (n=159) were males and 43.4% (n=122) were females giving M: F ratio of 1.3:1. The largest male and female studied populations were 10.3% (n=29) in 50-59 age range and 8.2% (n=9) in 40-49 respectively.

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The commonest examination was cranio-cerebral 62.5% (n=180), followed by abdomino-pelvic CT 3.5% (n=10). The commonest indication for cranio-cerebral CT was trauma (20%) followed by cerebro-vascular accident (CVA) 16.1%. Normal brain CT were 33 (18.3%) , whereas unrelated CT brain findings were 29 (16.1%).
11.4% (n=33) of 288 patients who underwent CT were candidates for test-running the machine (male to female ratio 1.12: 1) at no cost to the patient.
Conclusions: The commonest CT examinations in Uyo, Nigeria are cranio-cerbral with the commonest indications being trauma and CVA.

Keywords: Computed tomography; cranio-cerebral; Trauma; Abdomen.

1. INTRODUCTION

Computed tomography (CT) is a cross-sectional imaging modality that is based on ionizing radiation. But it has obviated the problem of tissue superimposition inherent in conventional radiography. When conventional radiography fails to resolve a clinical question, cross-sectional imaging with either CT or magnetic resonance imaging (MRI) is often demanded [1]. Similarly, alternative modality that could be substituted is ultrasonography as it has a peculiar advantage of real time imaging potential.

CT has salient peculiarities when compared to other imaging modalities. For example, operator dependency palpable in ultrasonography is absent in CT as CT images are reproducible. In same vein, CT has better cortical bone definition and readily displays calcifications unlike MRI. Volume rendered 3D CT has erased the extensive streak artefact seen on conventional axial CT imaging and multi-planar reconstructed images as well as susceptibility artefact on MRI bemoaning patients with metal hardware [1].

CT advent in 1970 has since revolutionized diagnostic radiology [2]. It is extensively regarded as among the most vital advances in medicine and its integration into routine care has dramatically improved patient health care [3]. Its scope in ailment management cut across all specialities in medicine. In fact, CT is a delight to Neurosurgeons and Neurologists. Use of CT for diagnostic evaluation has increased tremendously over the past 2 decades [3]. The total number of CT examinations performed annually in the United States has risen from approximately 3 million in 1980 to nearly 70 million in 2007 [3]. Children are not spared with about 4 million paediatric CTs done in United States [2]. Similar rapid increase in CT usage applies to other countries [2].

The above noted sharp increase in CT usage has been driven largely by advances in CT technology that make it extremely user-friendly, both for the patient and the physician [2]. Such technology has led to new frontiers of disease evaluations hitherto non-existent. For example, virtual colonoscopy and virtual bronchoscopy gave insight into the lumina of the colon and bronchus respectively.

Despite new grounds in medicine exploited through CT, its perennial problem is high radiation dose. By its nature, CT involves larger radiation doses than the more common, conventional x-ray [2]. Though the risks for any one person are not large but the increasing exposure to radiation in the population may be a public health issue in the future [2].

We aimed at evaluating computed tomographic examinations in University of Uyo teaching hospital with respect to type of examinations, demography and findings without specifics.

2. SUBJECTS AND METHODS

A retrospective study was carried on all computed tomographic studies performed in the Department of Radiology, University of Uyo teaching hospital, Uyo, Akwa Ibom state, Nigeria. The period started from the first day of test-running the newly installed CT machine which was 4th November, 2012. The period under review ended on 9th August, 2013. The CT scanner is Toshiba Activion 16, Japan, a 16 slice helical CT manufactured in 2009.

All patients who received CT imaging were included in the study. There were no other inclusion or exclusion criteria. Demographic information for each patient, (date of examination, age and gender) as well as their reason for obtaining CT imaging were extracted from duplicate copy of the formal radiology reports for each patient from departmental records. CT scans were classified based on the part of the body imaged like cranio-cerebral, abdomen, chest, spine and others.

Results were purely classified as normal with no pathological findings or CT with pathological findings or CT with unrelated findings. The specifics of the CT findings were beyond the scope of this study.

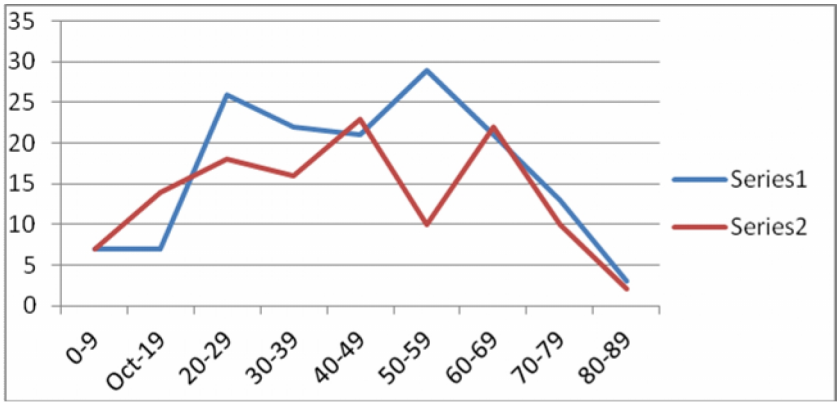
Results were analyzed with computer statistical package SSPS 13.

3. RESULTS

288 Patients were studied with adequate demographic data on 281 patients (Table 1 & graph 1). These 7 patients with incomplete demographic data were excluded from analysis as they were recorded as adults or had no gender documentation. Therefore 281 patients were analyzed. Of this number, 56.6% (n=159) were males and 43.4% (n=122) were females giving male: female ratio of 1.3:1. The largest male population studied was in the 50-59 age range with 10.3% (n=29). In females, the largest studied population was in the 40-49 age range with 8.2% (n=9). The least studied population in both sexes was in the 80-89 with 3 males and 2 females respectively.

Table 1. Showing age and sex distributions of studied population in university of uyo teaching hospital (UUTH) from 4th november, 2012 - 9th august, 2013

Age range	Males	Females
0-9	7	7
10-19	7	14
20-29	26	18
30-39	22	16
40-49	21	23
50-59	29	10
60-69	21	22
70-79	13	10
80-89	3	2
Total	159	122



Graph 1. Showing the age and sex distribution of studied population (serial 1-males and serial 2-females in uuth from 4th november, 2012 - 9th august 2013

Patients were referred from different specialties like neurology, trauma/ orthopedics, general surgery, family medicine, pneumology, cardiothoracic surgery, otorhinolaryngology, maxillofacial surgery, ophthalmology, gastrointestinal surgery, urology, accident/ emergencies, pediatric and peripheral hospital. Neurology, trauma/orthopedics and accident/emergency were the major referral portals (58.25%).

The commonest examination was cranio-cerebral and there were 180 cases (62.5%). This was followed by abdomino-pelvic CT 3.5% (n=10), chest 2.4% (n=7), Spine 1.32% (n=4). Others were 33.7% (n=97) (chart 1 and Table 2). In the cranio-cerebral CT, 16.1% (n=29) were due to CVA, 20% (n-36) were due to trauma, 4.4% (n=8) were due to headache and 3.3% (n=6) were due to space occupying lesions. Normal cranio-cerebral CT were 18.3% (n=33) whereas unrelated cranio-cerebral CT findings were 16.1% (n=29).

Out of the entire 288 studied patients, 11.4% (n=33) were used for test-running the machine with 1.12: 1 male to female ratio. These patients had clinical symptoms and were referred from various clinics in the hospital. The examinations were done at no cost to the patient.

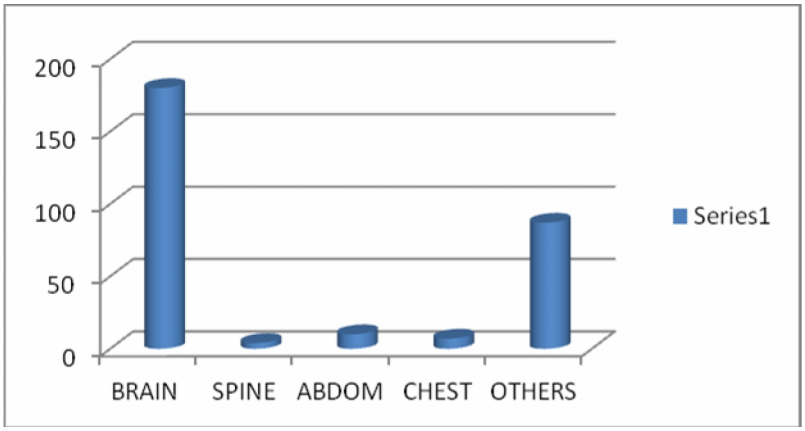


Chart 1. Showing the frequency of different types of ct examinations in uuth from 4th november, 2012 - 9th august, 2013

Table 2. Tabular display of major findings in chest ct in uuth from 4th november, 2012-9th august, 2013

S/no	Age(yrs)	Sex	Referring unit	Clinical finiding	Ct findings
1	63	M	Chest	breathlessness	COAD
2	36	M	Chest	breathlessness	Cystic bronchiectasis
3	34	F	Family med	MSS PAIN	Normal
4	74	M	Chest	Right lung consolidation	Rt lower lobe pneumonia
5	42	M	Accident &E	Penetrating Chest trauma	Left haemo-thorax
6	45	M	Surgical	Karposis sarcoma	Bilateral interstitial lung disease
7	14	M	Surgical	Hodgkin's lymphoma	Mediastinal adenopathy

COAD-Chronic obstructive airway disease, MSS- Musculoskeletal pain, Rt- right

4. DISCUSSION

It is really gratifying and most commendable that the management of University of Uyo teaching hospital considered it exigent and paramount to purchase a 16-slice helical computed tomography (CT) scanner rather than folding hands and groaning over the delay in the arrival of the CT machine allocated to it by the 'VAMED Project' of Federal government of Nigeria. This is definitely a stop gap but a far cry from the expected. This is because this is the only CT scanner serving the entire people of Akwa Ibom State and even its environ. Akwa-Ibom state is the highest producer of crude oil and gas in Nigeria and the state has population over 5 million people and a land area of 6,900 sq Km [4,5]. This translates to one CT scanner per 5 million populations. Whereas as at 1996 (17 years ago), a conducted survey revealed that the number of CT scanners per 1 million population was 26 in the United States and 64 in Japan [2]. We are not demoralised as a journey of one thousand miles starts with a step. This is against the backdrop that we are a third world country with numerous obligations contending with our meagre resources. A proof of the dire need of CT in the state was the unexpected number of patients with clinical indications that made themselves available for the free trial and knobology of the machine after installation. In that short period of trial which spanned only from 4th November to 8th November, 2012, 33 (11.4%) patients were scanned with male to female ratio of 1.12:1 despite numerical scaling down.

CT has tremendously transformed much of medical imaging through providing three-dimensional views of the organ or body region of interest [2]. Three-dimensional imaging endeavours to manifest 3D spatial relationships in a two-dimensional image [1]. Older CT technology usually needs multiple acquisitions to entirely view some pathologies [1]. But 16-slice multi-detector CT with its isotropic data sets needs acquisition in only one plane [1]. Subsequent reconstruction in real time to any other desired plane of interest can be performed to adequately display the pathology [1]. With the introduction of advanced workstations, 3D imaging can be produced and viewed with user-friendly real-time interactive display (Fig. 1.) [1]. Another advantage of 16-slice multi-detector CT is the ability to yield high-resolution volume data sets not attainable by older spiral CT capability [1]. The modern state of art of 16-slice multi-detector CT is its sub-second acquisition and isotropic data accompanied by multiple detector rows and fast gantry rotation times, such

that the acquisition time with a 16-slice multi-detector CT can now be reduced by approximately 25 times that of conventional spiral CT [1].

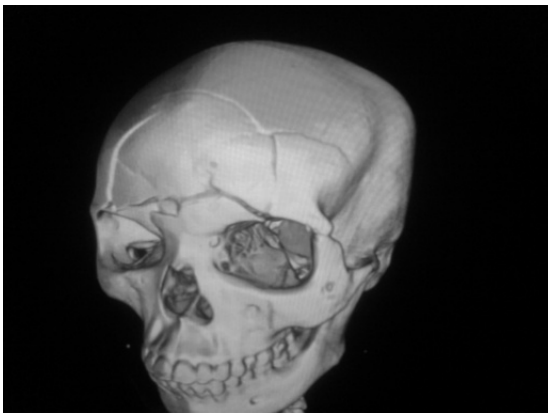


Fig. 1. 3d volume cranio-cerebral ct showing bilateral fractures of fronto-parietal calvarium

In this study no age group was spared of CT examination with 4.8% being children below 10 years of age (Table 1). This approximates to the estimates of the proportion of CT studies that are currently performed in children which range from 6% to 11% [2]. Congenital anomalies are often better demonstrated with 3D CT than conventional axial imaging alone, as imaging in the non-axial plane is mandatory for full anomaly definition [1]. The driving force for the growth of CT use in children is reduction in the time required to perform a scan (now less than 1 second) [2]. This significantly eliminated the need for anaesthesia to avert child mobility during image acquisition [2]. However adult bias in CT examinations still remains just like other studies (chart 1) [2]. This is not unconnected with high radiation dose of CT and greater propensity to carcinogenesis in younger age. The risk of cancer development in CT examinations depends on age, sex and type of CT examinations [3]. For example 1 in 270 women (1 in 600 men) who underwent CT coronary angiography at age 40 years will develop cancer from that CT scan [3]. The risks were approximately doubled for 20 year old patients but approximately 50% lower for 60 year old [3].

In this study, the most frequent type of CT examinations patients underwent is cranio-cerebral and this is comparable to other studies (chart 1) [3]. This could be due to the limited usefulness of conventional radiography in evaluating the brain, non-usefulness of ultrasonographic evaluation of the brain on closed fontanelles and local non-availability of any other neuro-imaging modalities like MRI. Indications like cerebrovascular accidents, traumatic brain injuries, headache, space occupying lesions, congenital brain lesions and seizures are readily evaluated with cranio-cerebral CT [1,6-13]. The rapid neuroimaging of a patient that has suffered CVA is a critical preamble to the emergent initiation of thrombolytic therapy [14]. CVA increases with age and is a frequent cause of death and disability in most parts of the globe [11,15]. CT can easily distinguish haemorrhagic from ischaemic CVA. Over 16% of patient who underwent cranio-cerebral CT in our study had positive radiographic features of CVA. CT can readily show hypodensity around the watershed area of the brain as a sensitive, prognostic, and reliable indicator of the degree of middle cerebral artery (MCA) territory that underwent infarction [10].

Brain herniations are also easily detected by CT and this becomes more useful when a patient is asymptomatic, awake, alert and neurologically intact. Brain herniation is defined as mechanical displacement of brain, cerebrospinal fluid, or blood vessels outside the compartments in the cranium that they normally occupy [9]. CT angiography with CT perfusion may represent a rapid noninvasive technique for diagnosis of brain death [16].

The care of the trauma patient is quite demanding, requiring speed and efficiency [17]. This therefore demands an imaging tool that is fast in image acquisition and permits simultaneous use of resuscitatory equipment. Given its fast imaging time and ability to produce high resolution images of the skeletal system, 16-slice multi-detector CT with thin collimation is the cross-sectional study of choice in both adult and paediatric trauma [1]. In many African countries, road traffic accident (RTA) is due to recent invasion into transport system by motor cyclists [18]. A common scenario in the city of Uyo where the CT scanner is located. 20% of all cranio-cerebral CTs in this study were due to trauma with road traffic accident being a major contributor. Computed tomography scan is effective in delineating soft tissue and bony injuries [19]. In the assessment of acute traumatic injuries, CT with multi-planar reconstructions and 3D mapping has been shown to display between 25% and 75% more sites of pathology compared with radiography (Fig. 1) [1]. Three-dimensional CT offers a method of detecting occult fractures not detected by radiography [1]. Both volume-rendered and shaded surface display 3D algorithms as well as multi-planar reconstructed images may be used to determine fracture extent and complexity, but volume-rendered 3D CT is useful for patients with gunshot wounds, where streak artefact can obscure pathology on imaging performed with other CT techniques (conventional axial CT images, multi-planar reconstructions and 3D shaded surface display images) [1,19].

Abdominal CT was the second most frequent CT done in our centre. Findings of physical examination are notoriously unreliable in some abdominal conditions like blunt abdominal injury with missed intra-abdominal injuries continuing to cause preventable deaths [17]. Unrewarding physical findings may be due to the presence of distracting injuries, altered mental state, and drug/ alcohol intoxication in the patient [17]. CT has shown to be reliable in the evaluation of blunt abdominal trauma in a selected group of patients, with overall sensitivity of 97%, specificity of about 95%. positive predictive value 82% and negative predictive value 100% [17]. The most commonly injured organs are the spleen, liver, retroperitoneum, small bowel, kidneys, bladder, colorectum, diaphragm and pancreas [17]. CT scan remains the standard criterion for the detection of solid organ injuries [17]. CT scan of the abdomen can also show other accompanying injuries, notably vertebral and pelvic fractures and injuries in the thoracic cavity. CT scans, unlike direct peritoneal lavage (DPL) or focused assessment with sonography for trauma (FAST) examinations, have the capability to determine the source of haemorrhage [17]. In addition, many retroperitoneal injuries go unnoticed with DPL and FAST examinations. The images can help quantify the amount of blood in the abdomen and can reveal individual organs with precision [17]. However CT has marginal sensitivity for diagnosing diaphragmatic, pancreatic and hollow viscus injuries [17].

CT of the chest is superior to chest computed radiography (CR) as it demonstrates roentgenographic abnormalities more often than CR (Fig. 2), provides new diagnostic information and clarifies CR abnormalities [13]. (Table 2) It supplements the combined diagnostic yield of CR and fibroptic bronchoscopy in some patients like localizing site of bleeding in patients with haemoptysis [13].

Other CT examinations done in our centre and classified as others in this study were paranasal sinuses, ear, lower limb, upper limb, jaw, angiography, joints and neck. In spine CT, cervical spine CT due to road traffic accident was the commonest in our study. A great many cervical spine fractures are missed on plain radiography and are seen only by CT [20,21].

Fig. 2. Mediastinal window of chest ct of a 36 year old man showing bilateral basal lung parenchymal cystic lesions with interstitial lesions and signet rings (features of cystic bronchiectasis)

Chronic rhinosinusitis is a frequently encountered disease with its diagnosis relying on clinical judgment based often on vague physical complaints and symptoms like facial pain, headache, postnasal catarrh and fatigue [22]. Objective evaluations exist with the introduction of the rigid endoscope and computed tomography (CT) [22]. Currently, CT scanning is the standard imaging in the evaluation of the paranasal sinuses being used in establishing the severity of disease, response to treatment and surgery [22].

Over 18% of our brain CTs were normal with no pathology seen. This brings to mind the application of caution in requesting for CT examinations considering its high radiation dose. Radiation doses varied significantly between the different types of CT examinations. The overall median effective doses ranged from 2 milli-sieverts (mSv) for a routine head CT scan to 31 mSv for a multiphase abdomen and pelvis CT scan [3]. CT is known to deliver much higher radiation doses than conventional radiography [3]. A typical chest CT scan typically delivers more than 100 times the radiation dose of a routine frontal and lateral chest radiograph [3]. This receipt of radiation dose by the patient has been worsened in part from improved CT techniques aim at increasing its scope in medicine. For example, increased speed of CT image acquisition allows vascular, cardiac, and multiphase examinations, all associated with higher doses [3]. Thus, greater use of CT has resulted in a concurrent increase in the medical exposure to ionizing radiation [3]. It has been reported that 30% or more of the CT examinations currently performed may be unnecessary [3]. Our lower value of 18% was due to the fact that there was a backlog of patients already seen by their clinicians with obvious or gross pathology who could not assess CT due to non-availability or cost. The European Commission Office of Radiation Protection and the Canadian Association of Radiologists developed guidelines highlighting where CT imaging should be curtailed [3]. This included repeating investigations that have already been done; over-investigating, imaging when it is unlikely to affect patient management because a positive finding is irrelevant such as surveillance of incidental findings [3].

Unrelated pathologies in the course of our CT studies were diverse constituting 16.1%.. These included Sino-nasal polyps, Rhinosinusitis, Foramina parietalis permagna, Hyperostosis frontalis interna, lytic skull lesions, Pansinusitis, Mastoiditis, Renal cortical cyst, Non-pnemuatization of sphenoid sinus, Osteochondritis dessicans and Phantom disc.

The significance of this study includes its ability to bring to fore the improvement in patients' health care in a city in a tropical environ as a result of installation of a modern imaging equipment (CT). Diseases not consonant with patients clinical history as well as innocuous incidental findings were readily discovered.

The limitations of our study include its retrospective nature with exclusion of some patients with incomplete data. Also, our study was not on the nitty-gritty of CT findings nor was it a correlative study between clinical and CT findings. These will be the basis of future studies.

5. CONLUSION

Recent acquisition and use of computed tomographic scanner in University of Uyo teaching hospital, Uyo, Nigeria has facilitated patient management in the hospital with the influx of patients to Radiology Department for different CT investigations.

The commonest CT examinations in Uyo is cranio-cerebral followed by abdomen. The commonest indication of such cranio-cerbral CT is trauma followed by cerebrovascular accident.

One 16 slice helical CT is a good step but grossly inadequate for the population. Additional acquisitions of CT and magnetic resonance imaging machines will be most complementary.

CONSENT

All authors declare that written informed consent was obtained from the patient (or other approved parties) for publication of this article and accompanying images.

ETHICAL APPROVAL

All authors hereby declare that all experimemts have therefore been performed in accordance with the ethical standards laid down in the 1964 Declaration of Helsinki.

ACNOWLEDGEMENTS

Chief Medical Director, University of Uyo teaching hospital (Prof Etete Peters), Former CMAC, UUTH (Dr Emmem Bassey) and present CMAC (Dr P. Udoh) for all concerted interest in equipping Radiology Department in less than a year.

The head of department of Radiology (Dr M C Ikpe) and other Radiology departmental staff for all the energy spent in the installation.
The Deputy Director of imaging (Mr Ekanem) and his team of Imaging scientists for their dedication in producing quality CT images.

Departmental Record officers and other Administrative Officers.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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Peer-review history:
The peer review history for this paper can be accessed here:
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