Research Paper

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Sneak peek on CT Scans in Children: How much of this scanning for children is actually necessary?

Medical Science

KEYWORDS : CT scan, justification,unnecessary radiation, children, radiology department.

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ABSTRACT

Background and Aims of study: *Computed Tomography (CT) is a diagnostic imaging modality, providing physicians with information which can help in diagnosis of serious diseases. CT scan has numerous benefits in a wide range of clinical cases. However, these benefits unfortunately are concomitant with increased exposure to radiation.*

The aims of this research are to look briefly at the situation of imaging the children by CT in the radiology department in King Abdulaziz University Hospital (KAUH), Jeddah, Saudi Arabia to measure the increasing frequency of children's exposure to CT scans in this department to protect children from the risk of unnecessary exposure, reduce the wastage of manpower and resources, avoid wasting the time of the patient, and ensure the selection of the most appropriate diagnostic procedure.

Method: A retrospective study conducted in the Department of Radiology, KAUH between 1 January and 31 December 2012.There were 690 children scanned by CT for different parts of the body, their data reviewed and analysed from radiology records to form the sample of the study.

Results: *The study revealed that there were 51.7% of radiological findings for CT scan considered significant and 48.3% non-significant.This result show that a huge percentage of children were given unnecessary exposure to radiation among those who received CT scans from the department in which the study was carried out.*

Conclusion: *From the study, it is concluded that most CT scan done for children were not justified as well as there were more radiological findings not confirmed the clinical diagnosis. However,these CT scans are important in most of the cases. Hence, there is a big concern about the increasing requests for unnecessary CT scan Therefore, it is necessary to paediatricians to be careful in requesting of CT scans unless it is necessary.*

1.Introduction

These days, it is noticeable that the use of CT scanning has grown so quickly in children. CT is used in child patients and, in recent years, its use has increased dramatically [1] and it has seen a steady increase in the number of scanners with the increase requesting of the CT examinations [2, 3]. In particular, CT scans are used widely in children due to the short time for clinical assessment and ease of application for patients with non-anesthetists, and young people, and / or uncooperative [4] . CT scan exposes the patient to a high radiation dose that is much greater than that received during scanning with other imaging modalities[5]. The main disadvantage of CT is the use of ionizing radiation, and thus, the risk of side effects caused by radiation, and induction of cancer is the most important. This is especially true in children , because the rapidly dividing cells in the tissues of children are more sensitive to radiation and up to 10 times more sensitive to radiation than adults [8].For literature searching, survey study conducted in the UK in 2008 through multicentre showed that CT has grown in frequency from 5% to 11% compared with 10 years earlier. In spite of , this relatively low frequency of examinations, compared to radiography and fluoroscopy, CT is the growing and dominant contributor to the total collective effective dose from X-ray examinations being responsible for around 68% of the total collective dose, compared to 40% in 1998, while the percentage contribution from radiographic and fluoroscopic examinations has nearly halved [9] . The most recent report of the National Council on Radiation Protection and Measurements (NCRP) states that the contribution of medical imaging to the annual effective dose of US population has risen to be almost the same as background radiation (48% of that from all sources) and CT alone amounts to 24% of exposure for all natural and man-made sources combined[10]. In the US, CT examinations have increased by 10% per year since 1993 [10]. CT is frequently used in children to look for clinically-important traumatic brain injury (ciTBI) [11, 12].There is a body of research showing the potential deleterious effects of medical radiation exposure to children, particularly radiation to the brain[13,14]. Multiple clinical rules have evolved to try to identify children at low risk of intracranial injury after severe head trauma as a way to avoid unnecessary radiation[15, 16].Yet, the indications for CT in these children remained controversial[13,14,15].

American College of Radiology "ACR Appropriateness Criteria", and the referral guidelines of The Royal College of Radiologists help the clinician (and radiologist) in deciding which imaging modality is the best for specific indications[16, 17].This is an attempt and quick look on the request forms of the CT -scan in the diagnostic radiology department, KAUH, Saudi Arabia to understand the situation. The current study is aimed to make an effort for the clinical assessment of the child before referring them to CT exam, while the main objective is evaluate, analyze and document the clinical and radiological findings in the department to protect our children from hazards of unnecessary radiation.

2.Materials and Methods

Retrospective study was done after obtaining ethical approval from the medical research ethical committee. Review and analysis of the data of pediatrics records were done in the department of radiology, KAUH from first of January to 31/ December 2012. The data of 690 paediatric patients who were scanned by CT following an international scanning guidelines and protocols, by qualified radiographic technologists and reported by expert consulting radiologists. Data had been collected using the data collection sheet and analyzed by using computerized programme.

Frequency was used to describe the general and presenting characteristics in the children and among those who received brain CT scans, divided by three locations including: first for emergency, the second for inpatient, and the third for outpatient. Adjustment for multiple comparisons was performed .There were no other inclusion/exclusion criteria laid out for the study. The data obtained was validated for completeness and consistency and analysed quantitatively using the statistical package SPSS and Microsoft Excel.P value was considered to be significant if it was <0.05 and the results were gathered to look at the trends that emerged with regard to the radiology electronic recording system. The results of the study are presented in the form of tables and included later in the study.

3.Results:

The majority of pediatrics scanned with CT were males 368 (53.3%),while females were 322 (46.7%) Table (3-1). the highest percentage was in the age of 1-5 Years (33.2%) Table (3-1).

Table (3-1): The sex and age groups distribution between 690 Pediatrics scanned in CT through this study in Radiology Department in King Abdulaziz University Hospital - Jeddah in 2012 is illustrated in the table below:

Category	Number	Percentage %
Gender		
Male	368	53.3
Female	322	46.7
Total	690	100.0
Age (Years)		
Under 1	140	20.3
1-5	229	33.2
6-10	162	23.5
11-15	159	23.0
Total	**690**	**100.0**

Frequency tables Table (3-2) were used to describe the general and presenting characteristics in the paediatrics and among those who received CT scans, divided by three locations which include: first for emergency, the second for inpatient, and the third for outpatient. Adjustment for multiple comparisons was performed. P values were used to assess for differences between the confirmed and not confirmed CT scans through different parts were screened in univariate models and variables with P values of P<0.01 were included in multivariate modelling. Non-significant variables were sequentially stepped out until only significant factors (P<0.01) remain in the final multivariate models. Statistically significant differences were found for CT Brain and CT Chest.

Table (3-2): Showed Comparative data.

CT-scan	Paediatrics location	Confirmed number and (Percentage)	Not confirmed number and (Percentage)	Total	ChiX2	P value
Brain	Emergency	49(31.6)	106(68.4)	155	10.775	0.005
	Inpatient	85(46.4)	98(53.6)	183		
	Outpatient	40(50.6)	39(49.4)	79		
Chest	Emergency	0(0.00)	1(100)	1	13.186	0.001
	Inpatient	45.(81.8)	10(18.2)	55		
	Outpatient	8(42.1)	11(57.9)	19		
Abdomen-pelvic	Emergency	9(56.3)	7(43.8)	16	2.064	0.356
	Inpatient	34(66.7)	17(33.3)	51		
	Outpatient	28(75.7)	9(24.3)	37		
Para nasal sinuses	Emergency	1(50.0)	1(50.0)	2	5.760	0.386
	Inpatient	3(60.0)	2(40.0)	5		
	Outpatient	11(100)	0(0.00)	11		
IAM and Facial bones	Emergency	2(100)	0(0.00)	2	3.612	0.164
	Inpatient	3(30.0)	7(70.0)	10		
	Outpatient	15(51.7)	14(48.3)	29		
Neck (Soft tissues)	Emergency	0(0.00)	0(0.00)	0	0.027	0.869
	Inpatient	7(58.3)	5(41.7)	12		
	Outpatient	8(61.5)	5(38.5)	13		
Vertebral column	Emergency	2(20.0)	8(80.0)	10	3.300	0.192
	Inpatient	2(50.0)	2(50.0)	4		
	Outpatient	1(100)	0(0.00)	1		
Limbs	Emergency	1(50.0)	1(50.0)	2	1.609	0.447
	Inpatient	2(66.7)	1(33.3)	3		
	Outpatient	16(84.2)	3(15.8)	19		

Overall, a total of 721 CT scans were scanned. 64(34.0%) of CT scanned in an emergency location confirmed the clinical diagnosis ,while 124 (65.9%) were not confirmed through our study Table (3-3) and this showed significant differences. The most common clinical diagnosis (reason of exam) among 721 CT examinations through our 690 children were 90 (21.6%) trauma/ CVA for brain,20 (26.7%) follow up for chest,33 (31.7%) follow up for abdomen-pelvic,6 (35.3%) headache for PNS,13 (31.7%).

Table (3-3): Total of CT scans.

Paediatrics location	Confirmed (+)	Not confirmed (-)	Total	ChiX2	P value
Emergency	64(34.0)	124(65.9)	188	33.203	<0.0001
Inpatient	181(56.0)	142(44)	323		
Outpatient	127(61.0)	81(38.9)	208		
Total	372(51.7)	347(48.3)	721	0.869	0.351

Mass/swelling for IAM or (facial bones), 11(44.0%) follow up for neck(soft tissues),10 (66.7%) trauma for Vertebral column, 13 (54.2%) lesion for limbs Table (3-4). There were other clinical diagnoses that could have been significant in the use of CT scan, but most of those were too few in number to be considered in the statistical analysis.

Table (3-4): The most common clinical diagnosis among 721 CT scan.

CT-scan	Most common clinical diagnosis	Frequency	Percentage
Brain	Trauma/CVA	90	21.6%
Chest	For follow up	20	26.7%
Abdomen-pelvic	For Follow up	33	31.7%
Para nasal sinuses	Headache	6	35.3%
IAM or (Facial bones)	Mass/Swelling	13	31.7%
Neck(Soft tissues)	For Follow up	11	44.0%
Vertebral column	Trauma	10	66.7%
Limbs	Lesion	13	54.2%

4.Discussion:

In our total children 690, the youngest child in this study was 1 day old. The highest age frequency distribution between (1 – 5) Years were 229(33.2%) (Table 3-1) .The study showed that the CT findings which did not confirm the clinical diagnosis 124 (65.9%) referred from paediatrics emergency department numbered more than those which confirmed the clinical diagnosis 64 (34.0%) Table (3-3**).** On the other hand, CT findings confirmed the clinical diagnosis 181 (56.0%) numbered more than those which did not confirm the clinical diagnosis from inpatient de-

partment 142 (44.0%) Table (3-3**).** Also CT findings which confirmed the clinical diagnosis 127 (61.0%) referred from paediatrics outpatient department more than those which were not confirmed the clinical diagnosis 81 (38.9%) Table (3-3).

Regarding to paediatrics emergency department at KAUH,study revealed that CT scans did not confirm the clinical diagnosis106 (68.4%) and 8 (80.0%) for brain and vertebral column respectively, while 49 (31.6%) of brain cases and just 2 (20.0%) of vertebral column confirmed the clinical diagnosis Table (3- 2**).** A Google search of previous studies found that CT of the head is sometimes used for patients who have sudden hearing loss[19]. This use is not indicated and offers no information which would improve the initial management of the patient[19]. In patients for which there are no other neurological findings, a history of trauma, or a history of ear disease, CT scans should not be used in response to sudden hearing loss[19]. Our study showed brain CT scans which did not confirm the clinical diagnosis 98 (53.6%), while 85 (46.4%) confirmed the reasons of brain CT referred from paediatrics inpatient department in KAUH P-value (0.005) Table (3-2**) and this** agreed with of researchers from UC Davis Health System and Boston Children's Hospital for more than 40,000 children evaluated in hospital emergency departments for head trauma reported that children who have only isolated loss of consciousness after head trauma do not routinely require CT scans of the head [20].

Their important findings were published in the journal JAMA Paediatrics and the PI of the original study showed his concern about " missing a clinically significant of head casualty, and the availability of CT machines, barely considered to be the main factors leading to an increasing the uses of CT over the past two decades" said Professor Kuppermann.The results of the current research also agreed with another study found that unconscious children due to head trauma, referring to the (PECARN traumatic brain injury prediction rules), had a very low rate of clinically important brain injuries – only 0.5 percent, or 1 in 200 children[20].According to "The Essential Physics of Medical Imaging," one head CT scan for a child — based on a youngster's age , is the equivalent to 140 chest x-rays[20]. Lee and Kuppermann noted that if the guidelines are applied appropriately, the use of unnecessary CT scans could be significantly reduced[20].

Kuppermann and his team were recently published two related studies in the Annals of Emergency Medicine in 2014, both studies documented that the presence of vomiting and scalp swelling in children alone, with no other symptoms and signs of head trauma, were not enough to justify an urgent CT scan. Rather than that, the research team said that children in similar cases should be put under observation for a period of time before sending them to CT department [20]. Peter Dayan, the lead author of these both recent studies and an associate professor of paediatrics at Columbia University in New York, said that "Head trauma in children results in approximately half a million visits to U.S. emergency departments annually" and also said "Our study provides the frontline physicians with important support to help them avoiding exposing children to unnecessarily radiation risks of CT imaging." These a huge amount of data for population sample collected by Kuppermann and colleagues in PECARN strongly supporting our results and explained the answer of questions about the best practices with a high degree of confidence[20].

The current study did not find a significantly higher percentage of CT findings which did not confirm the clinical diagnosis of our children sample in the inpatient nor outpatient. There are some limitations to this study, because this was a retrospective cohort study, the smaller sample size in patients made it difficult to assess the variables associated with CT use in children. In summary, the use of CT scans in children significantly increased by a number of variables including location of visit, type of provider and symptoms .Further studies specific to this population are needed to determine the actual need for CT.

5.Conclusion:

Ordering CT scan should be associated with the strong justification for requesting it in children. In this quick review was found an overview of the clinical diagnosis and CT imaging findings for children in KAUH. In conclusion, it is recommended that further research be conducted on this important issue.

Conflict of Interest Disclosure

The author of this research paper declares that there is no support from any organization for the submitted work; no financial relationships with any organizations that might have an interest in the submitted work in the last five years; and no other relationships or activities which could appear to have influenced the submitted work.

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Abbreviations:

PI	principal investigator
IAM	Internal Auditory canal or Meatus
CVA	Cerebrovascular Accident

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