Int J Pharm Bio Sci 2015 Oct; 6(4): (B) 37 - 42

Research Article **Allied Science**

International Journal of Pharma and Bio Sciences

ISSN
0975-6299

COMPARISON OF EFFECTIVE DOSE BETWEEN ADULT AND PAEDIATRIC CT BRAIN USING DOSE LENGTH PRODUCT

MS NITIKA C. PANAKKAL [1], MR SUSHIL YADAV[2] AND MS WINNIECIA DKHAR[3*]

[1]*Post Graduate Dept. of Medical Imaging Technology School of Allied Health Sciences, Manipal University, Manipal*
[2] *Assistant. Professor (Sr.Scale) Dept. of Medical Imaging Technology School of Allied Health Sciences Manipal University, Manipal*
[3]*Assistant Professor Dept. of Medical Imaging Technology School of Allied Health Sciences Manipal University, Manipal*

ABSTRACT

Paediatric patients receive a higher effective dose from CT examinations if the similar exposure parameters developed for adults are used. The aim of the study was to compare the effective dose between adult and paediatric patients during CT brain examination, using the dose length product and to evaluate the level of optimization of scan protocols. Dose information was collected for 64 patients who underwent CT brain, among which 32 were adults and 32 were paediatric patients. CT scan of adult and paediatric patient was performed using standard helical adult and child protocol respectively, routinely followed at Kasturba hospital, Manipal. The dose information was collected from a monitor on control console. The effective dose was calculated by using region specific conversion factors. The result showed that the mean effective dose in the paediatric group was 3.34mSv which is higher than adult group having an effective dose of 2.04mSv. The study concluded that the scanning protocols should be further optimized in the paediatric group. This focuses the importance of developing size specific protocols.

KEY WORDS: Computer Tomography, Effective Dose, Dose length product

MS WINNIECIA DKHAR
Assistant Professor Dept. of Medical Imaging Technology School of Allied Health Sciences Manipal University, Manipal

INTRODUCTION

Computed Tomography is a useful diagnostic tool in medicine. It has a significant role in the diagnosis and treatment of various diseases. The usage of CT has upsurge dramatically over the last two decades because it is fast, sensitive in diagnosing and readily available. Moreover the most common body part that is scanned using CT is the head[1] One of the main drawbacks of CT is the high dose delivered to the patient during a scan and therefore it is a big contributor of collective effective dose among all radiographic procedures[2].Effective dose is a term that quantifies the risk from partial – body exposure to that from an equivalent whole body dose. Children are considered more sensitive to radiation than adults. The basic principles of radiation protection involve justification of practice, optimization of the practice and consideration of reference levels. Justification of practice means that every examination has to have a total net positive benefit for the patient. Once the examination has been justified the next step is to optimize the dose. The challenge is to keep the doses as low as possible with optimum image quality. The various factors that affect the dose in CT include tube voltage (kVp), tube current-exposure time product (mAs), slice thickness and pitch. Adjustments of these factors according to the size and age can reduce the dose considerably and therefore reduces the risk of developing radiation induced effects in children. Because paediatric CT scans can be obtained using lower doses it is important for the radiologists as well as the technologists to understand the parameters that affect dose and be able to optimize it. Therefore, the purpose of this study was to evaluate the level of optimization of scan protocols by estimating the effective dose for adult and paediatric brain and also to find the difference in Effective dose in both the groups.

Methodology

On approval of institutional ethical committee, 64 patients referred for non-contrast CT scan brain were selected by convenience sampling technique. Sample included 32 adult and 32 paediatric patients with age ranging 2 to16 years. The paediatric age group was classified according to the FDA[3]. The CT scan for adult patients was performed using standard adult helical brain protocol and CT scan for children was performed using standard brain child protocol. All the scans were performed on 64 Slice MDCT at Dept. of Radio-diagnosis and Imaging, Kasturba Hospital, Manipal. The data was collected from the dose information displayed on CT monitor. The dose information contain details about the scan mode, kVp, mAs and dose descriptors like $CTDI_{(vol)}$, and total DLP for each scan. The effective dose was calculated from the dose length product using the following formula

E=k x DLP

Where, E is the effective dose, k is the conversion factor and DLP is the dose length product. All data for the head region for adults and pediatric patients is normalized to $CTDI_w$ measured in a 16cm diameter dosimetry phantom to derive the value of k [4]. As per European guidelines on quality criteria for CT, the values for k coefficients (conversion factor) are given in Table I. These values are set for five standard ages and are specific to the anatomical regions scanned but independent of the scanner model and operating conditions.[5,6] Further mean effective dose and the difference in effective dose for both the groups were calculated and statistical analysis was done using Mann Whitney U test.

Table I

Normalized values for effective dose- per dose length product (DLP) for head and (standard) patient ages[5]

Region of body	0- year old	1 - year old	5 -year old	10- year old	Adult
Head	0.011	0.0067	0.0040	0.0032	0.0021

RESULTS

Mean effective dose estimated for a CT brain scan for children was 3.43 ± 0.975 mSv and adults was2.04± 0.17 mSv as shown in figure I. The difference in mean effective dose received during CT head scans of paediatric and adults patients was found to be 1.302 mSv which is significantly high.

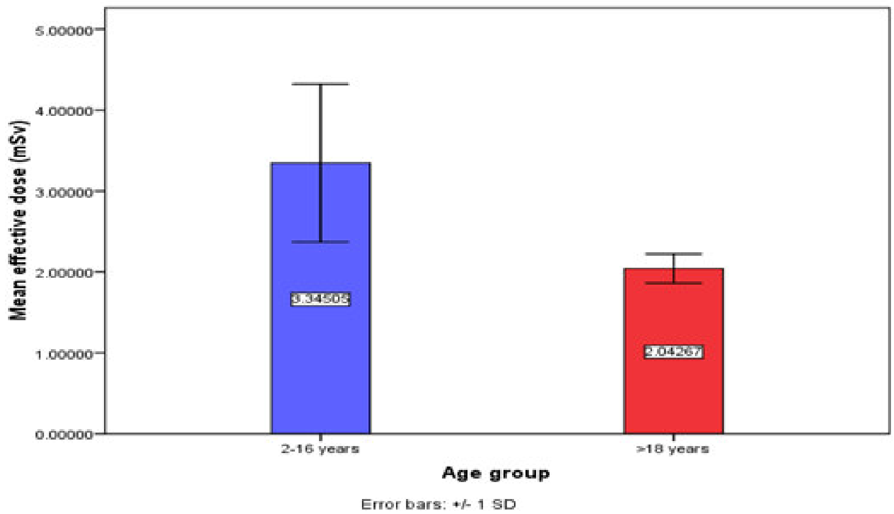

Figure I
Mean Effective Dose in Adult and Paediatric Group

The mean effective dose was observed to be increasing with decreasing age as shown in figure II, where adults received the least effective dose of 2.04± 0.17 mSv followed by paediatric group where children of 10-16 years received 2.5 ± 0.18 mSv, children of 5-9 years received 3.035± 0.31 mSv and children of 2-4 years received 4.66±0.39 mSv.

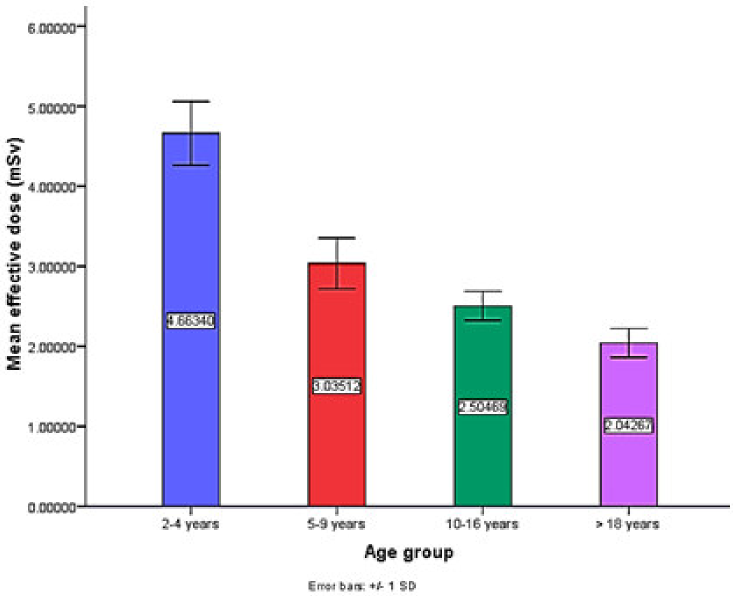

Figure II
Mean effective dose in adult and various paediatric groups

However CTDI $_{(vol)}$ and DLP shown in figure III & IV show a reduction in CTDI $_{(vol)}$ and DLP with decreasing age.

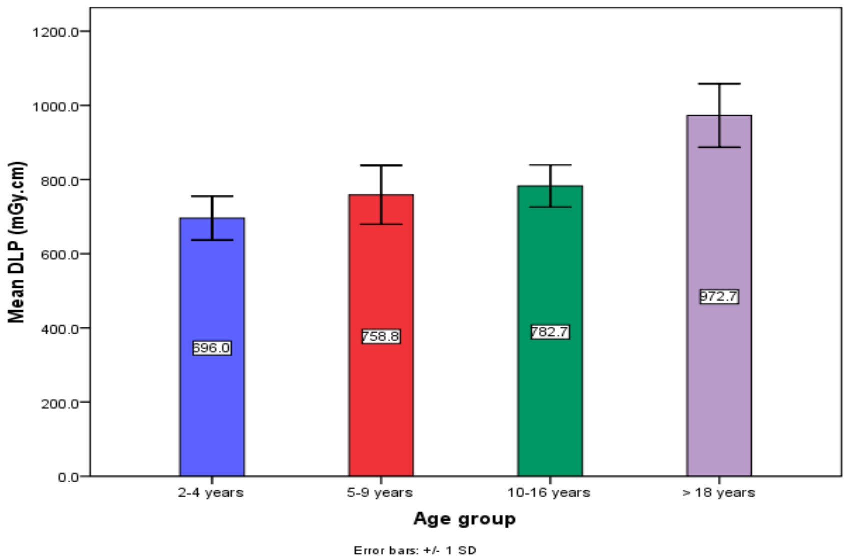

Figure III
Mean CTDI $_{(vol)}$ in Adult and Various Paediatric Groups

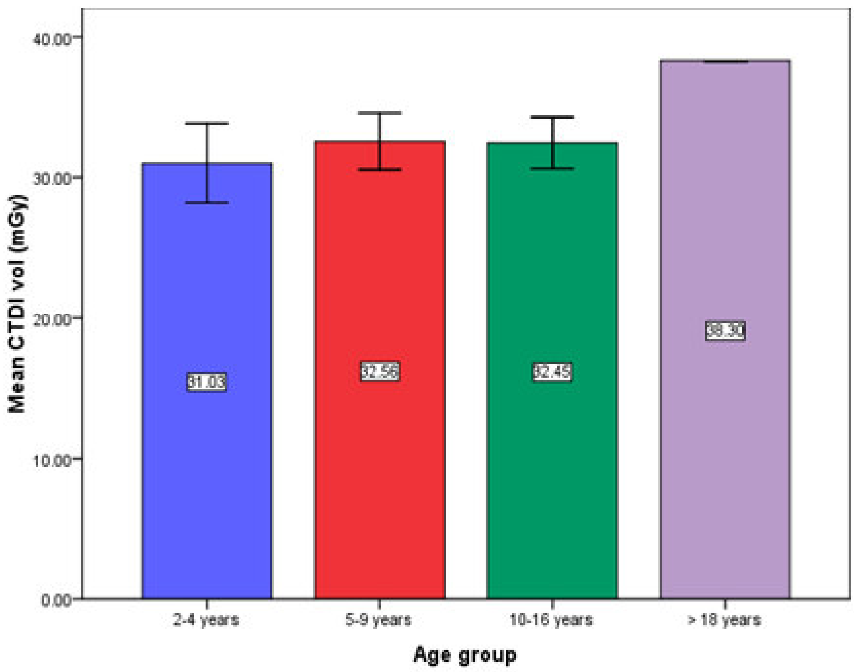

Figure IV
Mean DLP in Adult and Various Paediatric Groups

The mean values for effective dose parameters like CTDI $_{(vol)}$, DLP and effective dose for all paediatric patients and adults for the head are summarized in Table II

Table II
Mean CTDI $_{(vol)}$, DLP and effective dose for adult and paediatric group

Scan area	Group	CTDI$_{(vol)}$[mGy]	DLP[mGy.cm]	Effective dose[mSv]
Head	Adult	38.3	972.7	2.04
	Paediatric	32.03	748.14	3.345

DISCUSSION

The number of CT Examinations performed globally has increased rapidly[7]. Moreover the frequencies of paediatric CT examinations are also increasing. As the estimated lifetime cancer mortality risks due to radiation exposure is higher for children when compared to adults, children are more susceptible to radiation effects[8]. Many studies have been conducted to investigate the doses to paediatric patients. The present study evaluates the level of optimization of the scan protocol. This study agrees with most of the studies reported, showing that as age decreases the CTDI$_{(vol)}$ decreases with a corresponding increase in effective dose. The value for CTDI $_{(vol)}$obtained during CT head examination of the paediatric patient, in the present study is 32.03 mGy which is almost similar to the values reported by Kalpana et al and Eva et al. which were 27.3mGy and 33 mGy respectively. However the DLP reported in the present study was 2.2 times higher than those reported by Eva et al[9] and 1.9 times higher than study conducted by Kalpana et al[1]. In the present research the effective dose for children was found to be 3.34 mSv which is higher compared to 1.8mSv reported by Eva et al. The observed variation in DLP and Effective dose among these studies can be due to the variation in scan lengths because of two extra age groups (0-1, 1-2) included by Eva et al. Another reason can be due to more number of hospitals included in those studies which involves different CT vendors while present study is based on a single hospital for a single vendor. The value of adult effective dose obtained in the present study was found to be 2.04mSv which was higher than 1.7mSv as reported by Shrimpton et al[5] but lower than 2.4mSv as reported by Goddard et a[10]. Similarly the mean DLP as reported by Goddard et al was 603mGy.cm which was lower than the mean DLP of 972.7mGy.cm obtained in the present study. However this value was well within the reference levels reported by the European commission[6]which is 1050 mGy.cm. The reason for higher effective dose in children can be because of adjacent organs like thyroid and lung which are small and they proximity causes them to receive more scattered radiation[11]as reported by Huda et al. Another reason according to Mettler et al is due to the different values of age specific conversion factors which increase as age decreases[12] . However, if the DLP is kept low in paediatric CT practice, then it reduces the effective dose, irrespective of higher conversion factor[2]. Similarly the reason for decreasing value of CTDI $_{(vol)}$ and DLP with decreasing age can be because of the lower mAs of 250 adopted in the child protocol compared to higher mAs of 300 in adult protocol as CTDI $_{(vol)}$ does not quantify how much radiation any patient receives but simply indicates the intensity of radiation directed to the patient, which depends on specific kVp, mAs and pitch. However the observed variations in DLP are due to variations in the applied parameters and scan length[9]

CONCLUSION

The study showed that children have 1.6 times higher effective dose than adults. Therefore age specific protocols should be developed and the scanning protocol can be further optimized by adjusting scan parameters. Further studies can be conducted in order to achieve reduced radiation doses for CT examinations of the brain using optimal exposure parameters. Also further studies can be done in a large scale including more number of hospitals and scanners from various vendors. As there are limited studies reported in the country to evaluate the radiation dose and to set age specific standard protocol, studies can be conducted to establish the state and national diagnostic reference levels.

REFERENCES

1. Graves JM, Vavilala MS, Applegate KE, Jarvik JG, Rivara FP. Variation in CT Pediatric Head Results From a National Survey.AJR 204(3): ;293–301. (2015)
2. Deak PD, Smal Y, Kalender WA. Multisection CT Protocols : Sex and Age-specific Conversion Dose from Dose-Length Product.RSNA 257(1):158-166 . (2010)
3. Manual DS, Exclusivity P, Age S. Pediatric Exclusivity Study Age Group. U.S. Food and Drug Administration. 2009.
4. Christner J a., Kofler JM, McCollough CH. Estimating effective dose for ct using dose-length product compared with using organ doses: Consequences of adopting international commission on radiological protection publication 103 or dual-energy scanning. . AJR194(4):881-889(2010)
5. P C Shrimpton, M C Hillier,M A Lewis MD. Doses from Computed Tomography (CT) Examinations in the UK – 2003 Review.NRPB W67 .;:1–107.2005
6. European commission . European guidelines on quality criteria for computed tomography. Report EUR 16262. Brussels, Belgium . 2-106,(1999).
7. Ogbole GI. Radiation Dose in Paediatric Computed tomography : Risks and Benefits.Annals of ibadan postgraduate medicine. 8(2) :118–26.(2010)
8. Brenner DJ, Elliston CD, Hall EJ, Berdon WE. Estimated Risks of Radiation induced fatal cancer from pediatric CT. AJR. 176(2):289–96.(2001)
9. Friberg EG. Doses from pediatric CT examinations in Norway Are pediatric scan protocols developed and in daily use ? IAEA1:1–9. (2008)
10. Goddard C, Farsi A. Radiation doses from CT in the sultanate of Oman. BJR. 72(863):1073–1077(1999).
11. Huda W, Chamberlain C. Radiation dose to infants and adults undergoing head CT examinations.M Pubmed 28(3):393–9(2001).
12. Huda W, Mettler FA. Volume CT Dose Index and Dose-Length Product Displayed.RSNA 258(1) :236–42. (2011)