International Journal of Science and Healthcare Research
Vol.7; Issue: 4; Oct.-Dec. 2022
Website: ijshr.com
Original Research Article *ISSN: 2455-7587*

Observation and Management of Patient Radiation Dose in CT

Ritu Chauhan[1], Nitish Virmani[2], Sonia[3], Sahista[4], Hishma Shabir[5], Bhavna Tyagi[6], Madhuri[6]

[1]Assistant Professor, School of Paramedical Sciences, Starex University, Gurugram, Haryana, India
[2]Application Specialist, Boston Ivy-Medikabazaar, Mumbai, India
[3] Technician, Nemi Chand Medical College and Hospital, Panipat, Haryana, India
[4] Technician, Atrum Diagnostic Centre, Thakurganj, Bihar, India
[5]Technician, Premia Medicare Diagnostic Centre, Gurugram Haryana, India
[6]Assistant Professor, School of Paramedical Sciences, Starex University, Gurugram, Haryana, India

Corresponding Author: Ritu Chauhan

DOI: https://doi.org/10.52403/ijshr.20221005

ABSTRACT

Purpose: The aim was to observe and manage the patient radiation dose in CT

Methodology: A retrospective study of observation and management of patient radiation dose in CT was conducted for 5 months. During this period patient radiation dose was observed. CTDI and DLP were calculated. Patients were divided in three age groups (0-15 yrs, 16-55 yrs, 56-85 yrs) on the basis of pre-reproductive, reproductive & post-reproductive age. All the age groups were compared on the basis of dose received. Radiation dose was also compared in different body parts.

Result: A study was conducted in the department of radiology at SGT hospital for observation and management of the patient radiation dose in CT. Total 84 patients were taken in this study. Out of which 50 (59.5%) were males and 34 (40.4%) were females. In the age group of 0-15 yrs DLP was high in abdomen 772.47 mGy.cm and low in chest 234.22 mGy.cm. In the age group of 16-55 yrs DLP was high in head (809.51 mGy.cm) and low in neck (380.27 mGy.cm) and in the age group of 56-85 yrs DLP was high in head (923.63 mGy.cm) and low in chest (477.51 mGy.cm). Among all the age groups head dose was high in the age group of 56-85 yrs, neck dose was high in the age group of 56-85 yrs, chest dose was high in the age group of 16-55 yrs and abdomen dose was high in the age group of 56-85 yrs. The overall radiation dose was high in the age group of 56-85 yrs (37%) and less in the age group of 0-15 yrs (30%). It was observed that radiographers uses lead apron to cover the area of patient which is outside the ROI to protect the patient from unnecessary radiation dose. They always keep in mind that the centering of patient should be correct. They also avoid repeated exposure to the patient.

Conclusion: In this study, it was found that in head, neck and abdomen dose was high in the age group of 56-85 yrs and chest dose was high in the age group of 16-55 yrs. The overall radiation dose was high in the age group of 56-85 yrs which was 37% and lowest radiation dose was in the age group of 0-15 yrs which was 30%. It was observed that radiographers uses radiation protection devices to cover the area of patient which is not needed to be examine, to protect the patient from unnecessary radiation dose. They do the proper centering of patient. They also avoid repeated exposure to the patients. It is suggested to give less radiation dose to the patient.

Keywords: observation, management, patient, radiation, dose, computed, tomography

INTRODUCTION

CT is a medical imaging method employing tomography where digital geometry processing is used to generate a 3d image of internals of an object. Now a days, CT scan

is the most important imaging modality in radiology department as it provides high contrast images. Moreover, it takes less time for scanning.

Radiation dose in CT

Radiation is the small packet of energy that travel as a wave and transfer energy from one place to another. In CT patient receives more radiation dose than X-rays. One CT is equal to approximately 100-200 times of X-ray[1]. CTDI and DLP are the good measures to measure the radiation dose in CT[2]. Although, CTDI and DLP both are radiation dose but these are not same[3]. CTDI is the standardized measure of radiation output of the CT system. It provides the information about how much radiation is used to perform the study. It measures the exposure per slice and depends upon various machine settings including X-ray tube current, voltage, Z-axis collimation and pitch. CTDI does not depend upon the region of the body to be scanned or patient size. At the end of the scan CTDI is to be displayed but it is not the actual dose that is received by the patient until it is multiply with the scan length. The second key for patient dose is DLP which is the product of CTDIvol and irradiated length. It is the actual dose of the patient and proportional to the scan length.

Effects of radiation

The effect of radiation on tissue is of two types stochastic effect and deterministic effect[4]. Stochastic effect depends upon the probability. It has no threshold limit[5] and effect is seen in low radiation dose i.e. below 0.5 mGy. Its effects are seen late in the living organisms. Harmful effects of stochastic effect are cancer, skin erythema, cataract, hair loss, irreversible skin damage, sterility[6]. Moreover, deterministic effect depends upon the severity. It has threshold limit[5] and effects can be seen in high radiation dose i.e higher than 0.5 mGy. Its effect is seen early in the living organisms. Its effects are nausea, vomiting, diarrhoea. Absorption of radiation dose depends upon the thickness and the scan length of patient. If patient has more thickness, they absorb more radiation dose and if patient has less thickness, they receive less radiation dose. According to ICRP the MPD for occupational purpose is 20 mSv and for general public is 1 mSv per year[7].

Body Parts	Amount of radiation
CT Head	2 mSv
CT Neck	3 mSv
CT Chest	7 mSv
CT Abdomen	8 mSv

Table 1.1 Maximum permissible radiation dose in different parts of body[8]

Methods of radiation dose reduction in CT

Radiation dose reduction is very important in CT. Radiation exposure may leads to many problems from mild to severe. There are various methods for dose reduction like proper patient positioning, protection of non examine body part, CT parameters and setting, avoid repeated scan, explain procedure to the patient, optimization of CT. The patient should be isocentre. The centering of laser beam should coincide the patient. If there is any miscentering than FOV has to increase. Eventually, radiation dose will increase. During the scanning of patient, non examine part should be protected. Protective devices like lead apron, leaded gloves, thyroid shield, organ shield, gonad shield can be used to protect the non examine part from radiation exposure. ALARA principle must be followed during examination. Repeated exposures should be avoided. Good images should be taken in a single scan. Long exposure time may increase the radiation dose. Therefore, exposure time should be short. This can be avoided by clearly instruct the patient before examination like to remain still during examination, holding the breath during scan. This helps in avoiding motion artifact and repeated scan, thus helps in reducing radiation dose to the patient. Moreover, dose can be reduced by minimizing tube current, tube potential and scan length[9]. CT examinations should be performed under the responsibility of radiologist according to national

regulations. Standard examinations protocols should be available. Quality criteria can be radiologists, radiographers and medical physicists as a check on the routine performance of entire imaging process. Radiographer should avoid covering the large FOV if pathology can be seen in less FOV. This helps in avoiding unnecessary radiation dose to the patient.

AIM

This study is done to observe and manage the patient radiation dose in CT in department of Radio-Diagnosis at SGT Hospital.

- To compare the radiation dose received in different body parts
- To compare the radiation dose received in different age group
- To know the methods of management of patient radiation dose

METHOD AND MATERIALS

Research design and methodology are fundamental aspects of the research process. These should be selected cautiously because the success of a research project relies heavily on them. This was a retrospective study that was done by taking 84 patients who came into the department for their diagnosis at SGT hospital. The data was collected of 5 months from October 2018 - February 2019 under the supervision of experts and existing radiologist. Data was collected by the convenience sampling method as the data was taken from the section of population which was easily accessible or readily available to the researcher. In this study researcher found the radiation dose received in different age group and body parts. Radiation dose was calculated in head, neck, chest and abdomen. Patients were divided into three age groups (0-15 yrs, 16-55 yrs, 56-85 yrs) on the basis of pre-reproductive, reproductive & post-reproductive age. All the age groups were compared on the basis of dose received. Radiation dose was also compared in different body parts. Consent form was filled up by the patients. All the patients of age group < 85 were included in this study. All the staff members, radiographers and radiologists were excluded. The current study was a quantitative study. It was well-defined, mathematical or numerical analyzed. Mean average, relative percentage and standard deviation were found in this study. Data is represented by using pie chart, bar graph and tables

Sample size

Age group	Number of patients
0-15	25
16-55	31
56-85	28
Total	84

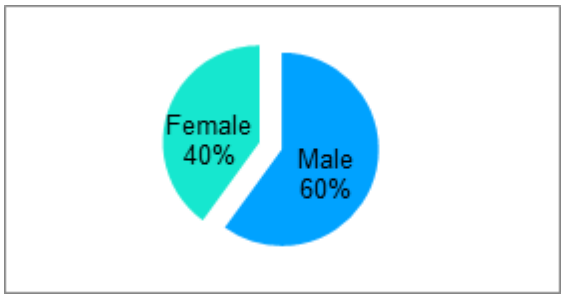
Table No 1.2 Shows sample size of the study related to the age group

Body parts	Number of patients
Head	24
Neck	12
Chest	23
Abdomen	25
Total	84

Table No. 1.3 Shows sample size of the study related to different body parts

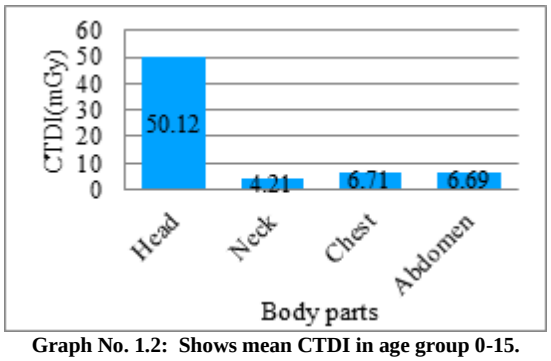
RESULT

Eighty four patients were taken in this study out of which 50 (60%) were males and 34(40%) were females. The mean age of these patients was 35.07 years (age range 2-85) and mean ± SD was 35.07± 24.09 years. Mean age of females and males was 40.8 years (age range 6-85 years) and 33.52 years (age range 6-85 years) respectively. Mean ± SD in females and males was 40.8± 22.7 years and 33.52± 24.1 years respectively.



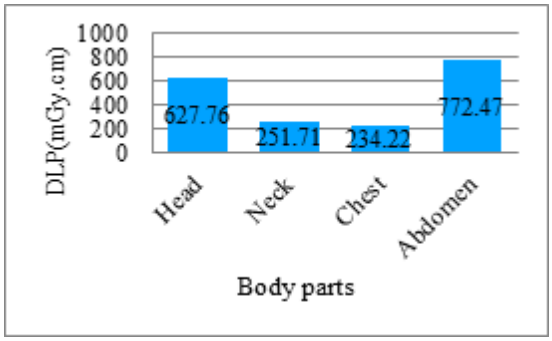
Graph 1.1 Ratio of gender

Mean CTDI value in head was 50.12 mGy and mean ± SD was 50.12 ± 0.47, mean CTDI value in neck was 4.21 mGy and mean ± SD was 4.21 ± 0.007, mean CTDI value in chest was 6.71 mGy and mean ± SD was 6.71 ± 1.65, mean CTDI value in abdomen was 6.69 mGy and mean ± SD was 6.69 ± 0.38. Minimum and maximum value of CTDI in head was 49.27 mGy and 50.82 mGy resp. Minimum and maximum value of CTDI in neck was 4.21 mGy and 4.22 mGy resp. Minimum and maximum value of CTDI in chest was 4.24 mGy and 8.82 mGy resp. Minimum and maximum value of CTDI in abdomen was 6.41 mGy and 7.21 mGy resp. It was found that in the age group of 0-15 yrs more CTDI was in head and less in neck.



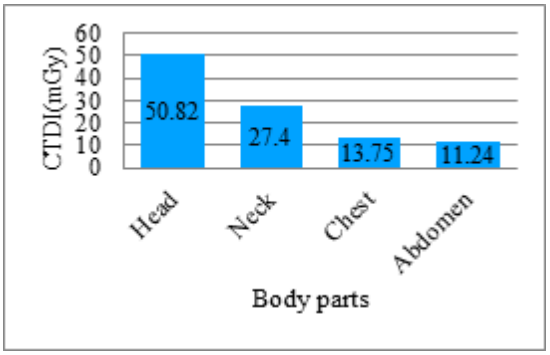
Graph No. 1.2: Shows mean CTDI in age group 0-15.

Mean DLP value in head was 627.756 mGy.cm and mean ± SD was 627.756± 100.1, mean DLP value in neck was 251.71 mGy.cm and mean ± SD iswas 251.71± 0.71, mean DLP value in chest was 234.216 mGy.cm and mean ± SD is 234.216± 10.09, mean DLP value in abdomen is 772.47 mGy.cm and mean ± SD was 772.47± 12.58. Minimum and maximum value of DLP in head was 494.24 mGy.cm and 851.24 mGy.cm resp. Minimum and maximum value of DLP in neck was 251.21 mGy.cm and 252.22 mGy.cm resp. Minimum and maximum value of DLP in chest was 224.12 mGy.cm and 251.21 mGy.cm resp. Minimum and maximum value of DLP in abdomen was 752.41 mGy.cm and 797.42 mGy.cm resp. It was found that in the age group of 0-15 yrs more DLP was in abdomen and less in chest.



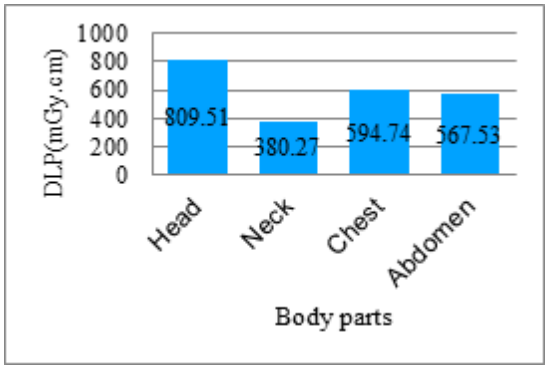
Graph No. 1.3 Shows mean DLP in age group 0-15.

Mean CTDI value in head was 50.82 mGy and mean ± SD was 50.82 ± 0.7, mean CTDI value in neck was 27.4 mGy and mean ± SD was 27.4 ± 8.6, mean CTDI value in chest was 13.75 mGy and mean ± SD was 13.75 ± 4.3, mean CTDI value in abdomen was 11.24 mGy and mean ± SD was 11.24 ± 5. Minimum and maximum value of CTDI in head was 50.23 mGy and 52.24 mGy resp.. Minimum and maximum value of CTDI in neck was 17.2 mGy and 36.31 mGy resp. Minimum and maximum value of CTDI in chest was 4.84 mGy and 21.22 mGy resp. Minimum and maximum value of CTDI in abdomen was 4.81 mGy and 22.77 mGy resp. It was found that in the age group of 16-55 yrs more CTDI was in head and less in abdomen.



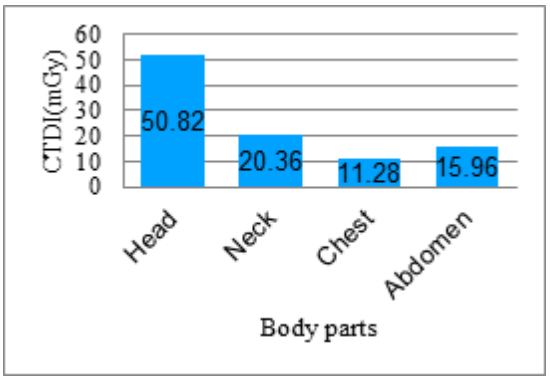
Graph No. 1.4: Shows mean CTDI in age group 16-55.

Mean DLP value in head was 809.51 mGy.cm and mean ± SD was 809.51 ± 238.85, mean DLP value in neck was 380.27 mGy.cm and mean ± SD was 380.27 ± 294.07, mean DLP value in chest was 594.74 mGy.cm and mean ± SD was 594.74 ± 134.04, mean DLP value in abdomen was 567.53 mGy.cm and mean ± SD was 567.53 ± 1275.78. Minimum and maximum value of DLP in head was 324.12 mGy.cm and 949.89 mGy.cm resp. Minimum and maximum value of DLP in neck was 81.42 mGy.cm and 720.12 mGy.cm resp. Minimum and maximum value of DLP in chest was 435 mGy.cm and 812.87 mGy.cm . resp. Minimum and maximum value of DLP in abdomen was 256.51 mGy.cm and 1140.25 mGy.cm resp. It was found that in the age group of 16-55 yrs more DLP was in head and less in neck.



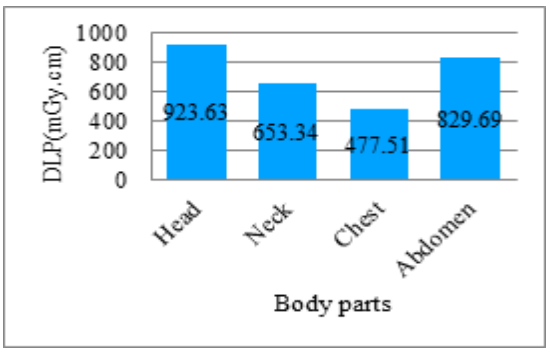
Graph No. 1.5 Shows mean DLP in age group 16-55.

Mean CTDI value in head was 50.82 mGy and mean ± SD was 50.82 ± 0.82, mean CTDI value in neck was 20.36 mGy and mean ± SD was 20.36 ± 12.1, mean CTDI value in chest was 11.28 mGy and mean ± SD was 11.28 ± 4.3, mean CTDI value in abdomen was 15.96 mGy and mean ± SD was 15.96 ± 7.8. Minimum and maximum value of CTDI in head was 50.23 mGy and 52.24 mGy resp.. Minimum and maximum value of CTDI in neck was 8.24 mGy and 32.61 mGy resp. Minimum and maximum value of CTDI in chest was 4.55 mGy and 20.8 mGy resp. Minimum and maximum value of CTDI in abdomen was 8.43 mGy and 24.83 mGy resp. It was found that in the age group of 56-85 yrs more CTDI was in head and less in chest.



Graph No. 1.6. Shows mean CTDI in age group 56-85.

Mean DLP value in head was 923.63 mGy.cm and mean ± SD was 923.63± 22.40, mean DLP value in neck was 653.34 mGy.cm and mean ± SD was 653.34± 310.62, mean DLP value in chest was 477.51 mGy.cm and mean ± SD was 477.51± 244.23, mean DLP value in abdomen was 829.69 mGy.cm and mean ± SD was 829.69± 239.91. Minimum and maximum value of DLP in head was 899.07 mGy.cm and 952.44 mGy.cm resp. Minimum and maximum value of DLP in neck was 314.42 mGy.cm and 924.48 mGy.cm resp. Minimum and maximum value of DLP in chest was 212.44 mGy.cm and 756.49 mGy.cm resp. Minimum and maximum value of DLP in abdomen was 412.42 mGy.cm and 992.22 mGy.cm resp. It was found that in the age group of 56-85 yrs more DLP was in head and less in chest.



Graph No. 1.7 Shows mean DLP in age group 56-85.

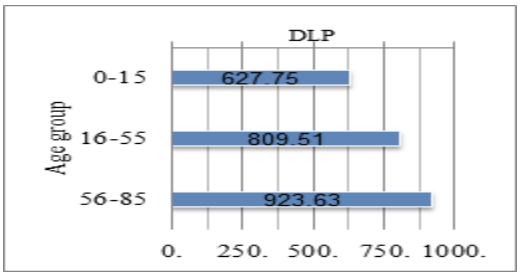
CT Protocol	CTDI (0-15 yrs)		CTDI (16-55 yrs)		CTDI (56-85 yrs)	
	Mean	**Range**	**Mean**	**Range**	**Mean**	**Range**
Head	50.12 ± 0.47	49.27-50.82	50.82 ± 0.7	50.23-52.24	50.82 ± 0.82	50.23-52.24
Neck	4.21 ± 0.007	4.21-4.22	27.4 ± 8.6	17.2-36.31	20.36 ± 12.1	8.24-32.61
Chest	6.71 ± 1.65	4.24-8.82	13.75 ± 4.3	4.84-21.22	11.28 ± 4.3	4.55-20.8
Abdomen	6.69 ± 0.38	6.41-7.21	11.24 ± 5	4.81-22.77	15.96 ± 7.8	8.43-24.83

Table1.4 Shows CTDI in different age group

CT Protocols	DLP (0-15 yrs)		DLP (16-55 yrs)		DLP (56-85 yrs)	
	Mean	**Range**	**Mean**	**Range**	**Mean**	**Range**
Head	627.756± 100.1	494.24-851.24	809.51 ± 238.85	324.12-949.89	923.63± 22.40	899.07-952.44
Neck	251.71± 0.71	251.21-252.22	380.27 ± 294.07	81.42-720.12	653.34± 310.62	314.42-924.48
Chest	234.216± 10.09	224.12-251.21	594.74 ± 134.04	435-812.87	477.51± 244.23	212.44-756.49
Abdomen	772.47± 12.58	752.41-797.42	567.53 ± 1275.78	256.51-1140.25	829.69± 239.91	412.42-992.22

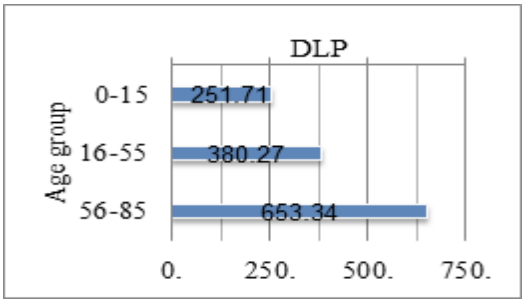
Table 1.5 Shows DLP in different age group

Mean DLP value in head was 627.75 mGy.cm and mean ± SD is 627.756± 100.1. Mean DLP value in head was 809.51 mGy.cm and mean ± SD is 809.51 ± 238.85. Mean DLP value in head was 923.63 mGy.cm and mean ± SD is 923.63± 22.40. It was found that in head patients of age group 56-85 yrs received more radiation dose and patients of age group 0-15 yrs received less radiation dose



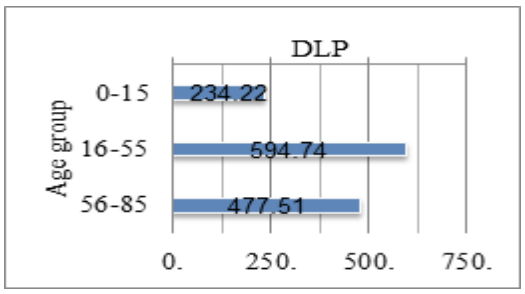
Graph No. 1.8 Shows radiation dose in head in all age group

Mean DLP value in neck was 251.71 mGy.cm and mean ± SD was 251.71± 0.71. mean DLP value in neck was 380.27 mGy.cm and mean ± SD was 380.27 ± 294.07. mean DLP value in neck was 653.34 mGy.cm and mean ± SD was 653.34± 310.62. It was found that in neck patients of age group 56-85 yrs received more radiation dose and patients of age group 0-15 yrs received less radiation dose



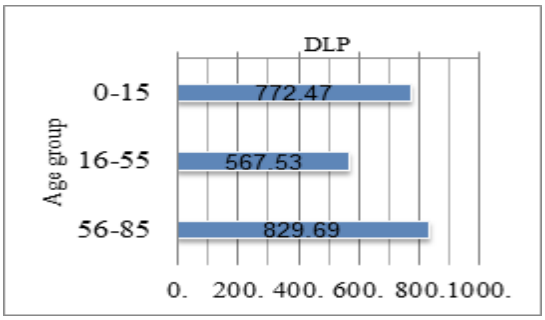
Graph No. 1.9 Shows radiation dose in neck in all age group

Mean DLP value in chest was 234.216 mGy.cm and mean ± SD was 234.216± 10.09. mean DLP value in chest was 594.74 mGy.cm and mean ± SD was 594.74 ± 134.04. mean DLP value in chest was 477.51 mGy.cm and mean ± SD was 477.51± 244.23. It was found that in chest patients of age group 16-55 yrs received more radiation dose and patients of age group 0-15 yrs received less radiation dose



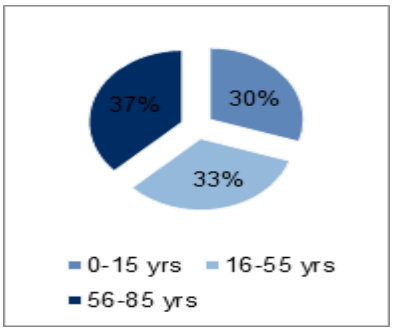
Graph No. 1.10 Shows radiation dose in chest in all age group

Mean DLP value in abdomen is 772.47 mGy.cm and mean ± SD is 772.47± 12.58. mean DLP value in abdomen is 567.53 mGy.cm and mean ± SD is 567.53 ± 1275.78. mean DLP value in abdomen is 829.69 mGy.cm and mean ± SD is 829.69± 239.91. It was found that in abdomen patients of age group 56-85 yrs received more. radiation dose and patients of age group 16-55 yrs received less radiation dose



Graph No. 1.11 Shows radiation dose in abdomen in all age group

In age group 0-15 radiation dose was 30%. In age group 16-55 radiation dose was 33%. In age group 56-85 radiation dose was 37%. It was found that radiation dose was received more in age group 56-85 and lowest radiation dose was received in age group 0-15.



Graph 1.12 Shows comparison of overall radiation dose in all age group

DISCUSSION

CT radiation dose vary greatly across the different hospitals regarding parameters, on the type of machines and way of handling of patients. In the present study, researcher examined eighty four patients who were referred to SGT hospital and research institute. In the study done by Strauss KJ[10] it was found that maximum radiation dose was received by the higher age group and less radiation dose was received by paediatric patients which was consistent with this study. In this study maximum radiation dose was received by higher age group 56-85 yrs and low radiation dose was received by the lower age group 0-15 yrs. In the study conducted by Atli E[11] et. al. median CTDI was low in head, chest and abdomen. Maximum median DLP was found in head and chest which and low in abdomen. In the present study in the age group of 0-15 yrs maximum mean CTDI was in head 50.12 mGy and minimum was in neck 4.21 mGy. Maximum mean DLP was in abdomen 772.47 mGy.cm and minimum mean DLP was in neck 251.71 mGy.cm. In the age group of 16-55 maximum mean CTDI was in head 51.16 mGy and minimum was in chest 13.75 mGy. Maximum mean DLP was in head 809.51 mGy.cm and minimum mean DLP was in neck 380.27 mGy.cm. In the age group of 56-85 maximum mean CTDI was in head 52.1 mGy and minimum was in chest 11.28 mGy. Maximum mean DLP was in head 923.63 mGy.cm and minimum mean DLP was in chest 477.51 mGy.cm. Maximum mean head dose was in age group 56-85 yrs which was 923.63 mGy.cm. Maximum mean neck dose was in age group 56-85 yrs which was 653.34 mGy.cm. Maximum mean chest dose was in age group 16-55 yrs which was 594.74 mGy.cm. Maximum mean abdomen dose was in age group 56-85 yrs which was 829.69 mGy.cm. In this study it was found that among all the age groups, the age group of 56-85 yrs radiation dose was more in head, neck and abdomen. In the age group 16-55 yrs radiation dose was more in chest. The overall radiation dose was high in the age group of 56-85 yrs which was 37% and lowest radiation dose was in the age group of 0-15 yrs which was 30%. In the age group 16-55 overall radiation dose was 33%. It was also found that radiographers covers the area outside the ROI with lead apron to protect the part from unwanted radiation. They also do the proper positioning of patients.

CONCLUSION

CT radiation dose vary greatly across the different hospitals which depends upon the various parameters, on the type of machine or on the way of handling of patients. In the present study radiation dose was found in different age group and different body part as well. In this study it was found that in the age group of 56-85 yrs radiation dose was more in head, neck and abdomen. In the age group 16-55 yrs radiation dose was more in chest. The overall radiation dose was high in the age group of 56-85 yrs which was 37% and lowest radiation dose was in the age group of 0-15 yrs which was 30%. In the age group 16-55 overall radiation dose was 33%. It was observed that radiographers use lead apron to cover the area of patient which is outside the ROI to protect the patient from unnecessary radiation dose. They also always keep in mind that the centering of patient should be correct. They also avoid repeated exposure to the patients. It is suggested to use less radiation dose for the patients and use all protective devices during the examination of patients like thyroid shield, gonad shield.

Contributors

All authors contributed to the design of the work, data acquisition, analysis and have approved the final version.

Source of Funding: This study did not receive any specific grant from funding agencies in the commercial, public, or not-for-profit sectors.

Conflict of Interest: None

Disclosure: Authors did not receive any type of commercial support in form of either financial support or compensation for this study.

Ethical Approval: Approved

REFERENCES

1. Watson S. Can CT Scans Lead to Cancer. Webbed. 2021
2. Bindman RS, Miglioretti MD *et al.* CTDIvol, DLP and effective dose are excellent measures for use in CT quality improvement. Radiological Society of North America. 2011;261(3);999
3. Hamada N, Fujimichi Y. Classification of radiation effects for dose limitation purposes: history, current situation and future prospects. J of Radiation Research. 2014;55(4):629-640
4. McCullough CH, Leng S *et al*. CT Dose Index and Patient Dose: They Are *Not* the Same Thing. RSNA. 2011;259(2);311-316
5. Choudhary S. Deterministic and stochastic effects of radiation. Canc therapy & Once Int J. 2018; 12(2): 555834
6. Jones J, Murphy A. Deterministic effects. Radiopaedia, 2020
7. Smith LR. Dose recommendation. International Commission on Radiation and Protection. 2006.1551 (925) 283-1850
8. Mettler FA Jr, Huda W, Yoshizumi TT, Mahesh M. Effective doses in radiology and diagnostic nuclear medicine: a catalog. Radiology. 2008: 248(1): 254-63.
9. Trattner S, Pearson GDN, Chin C*et. al*. Standardization and optimization of CT protocols to achieve low dose. J Am Coll Radiol. 2014;11(3):271-278.
10. Strauss KJ, Somasundaram E, Sengupta D, et. al. Radiation Dose for Pediatric CT: Comparison of Pediatric versus Adult Imaging Facilities. Radiology.2019;291(1):158-167.
11. Atli E, Uyanik SA, Gumus B. Radiation doses from head, neck, chest, abdominal CT examinations: an institutional dose report. Diagn Interv Radiol. 2021: 27(1): 147-151

How to cite this article: Ritu Chauhan, Nitish Virmani, Sonia et.al. Observation and management of patient radiation dose in CT. *International Journal of Science & Healthcare Research.* 2022; 7(4): 27-34. DOI: *https://doi.org/10.52403/ijshr.20221005*

******