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Original Article

Diagnostic Reference Levels of Head CT Scan at Garoua Regional Medical Imaging Center

Niveaux de Référence Diagnostiques de la Tomodensitométrie de la Tête au Centre Régional d'Imagerie Médicale de Garoua

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ABSTRACT

Introduction. The Diagnostic Reference Levels (DRLs) is defined as the reference values for typical radiation doses in specific imaging procedures. This study focuses on establishing Diagnostic Reference Levels (DRLs) for head CT scans at the Garoua Regional Medical Imaging Center. **Methodology**. The data were collected at the regional medical imaging center of the north. Radiation dose data were collected from the local ct scanners ge revolution ct 65-slice, ge healthineers, europe -central and eastern) over a period of 12 months from january to december 2023. And analyzed using microsoft excel 2016 and spss software version 23. The study explores imaging protocol parameters, such as voltage, current, pitch, and scan length, providing comprehensive insights into the technical aspects of head CT procedures. **Results**. Over a 12-month period, data from 621 patients were analyzed, revealing a male predominance with 52.5% and the most represented age group was 40 to 59 years old. the stroke protocol was the most used one with trauma as indication with more than 27.2% of the Head CT examination. For stroke and trauma, a voltage of 120 Kv, variable current (265 mAs for trauma), pitch range (0.52) **Conclusion**. DRLs are not the suggested or ideal dose for a particular procedure, but rather represent the level at which an investigation of the appropriateness of the dose should be conducted. They are supplements to professional judgment and are intended to enable individual CT users and the community at large to identify and address consistently high doses.

RÉSUMÉ

Introduction. Les Niveaux de Référence Diagnostiques (NRD) sont définis comme les valeurs de référence pour les doses de radiation typiques dans des procédures d'imagerie spécifiques. Cette étude se concentre sur l'établissement des Niveaux de Référence Diagnostiques (NRD) pour les scanners cérébraux par CT au Centre Régional d'Imagerie Médicale de Garoua. **Méthodologie.** Les données ont été recueillies au centre régional d'imagerie médicale du nord. Les données de dose de radiation ont été collectées auprès des scanners CT locaux (ge revolution ct 65-slice, ge healthineers, europe - central and eastern) sur une période de 12 mois, de janvier à décembre 2023. Et analysées à l'aide de Microsoft Excel 2016 et du logiciel SPSS version 23. L'étude explore les paramètres de protocole d'imagerie, tels que la tension, le courant, le pas et la longueur de balayage, fournissant des informations complètes sur les aspects techniques des procédures de CT cérébrales. **Résultats.** Sur une période de 12 mois, les données de 621 patients ont été analysées, révélant une prédominance masculine avec 52,5% et le groupe d'âge le plus représenté était celui des 40 à 59 ans. Le protocole d'accident vasculaire cérébral était le plus utilisé, avec un traumatisme comme indication dans plus de 27,2% des examens de CT cérébrale. Pour l'accident vasculaire cérébral et le traumatisme, une tension de 120 Kv, un courant variable (265 mAs pour le traumatisme), une gamme de pas (0.52). **Conclusion.** Les NRD ne sont pas la dose suggérée ou idéale pour une procédure particulière, mais représentent plutôt le niveau auquel une investigation de l'adéquation de la dose devrait être effectuée. Ils sont des compléments au jugement professionnel et ont pour but de permettre aux utilisateurs individuels de CT et à la communauté en général d'identifier et de régler les doses élevées de manière cohérente.

INTRODUCTION

In recent decades, the widespread utilization of Computed Tomography (CT) scans has revolutionized medical imaging, providing clinicians with invaluable diagnostic information for a diverse range of medical conditions **(1).**

KEY RESULTS

Aim of the study

This study focuses on establishing Diagnostic Reference Levels (DRLs) for head CT scans at the Garoua Regional Medical Imaging Center.

Key results

1. The stroke protocol was used in 46.7%% of cases, most often for trauma (27.2%) while sinus protocol was used in 32.3% of patients, most often for chronic headache (17.2%).
2. Reference values for stroke and trauma were: voltage of 120 Kv, variable current (265 mAs for trauma), pitch range (0.52).
3. Mean DLP (mGy/cm) was 675 for stroke protocol and 81 for sinus protocol.

While the benefits of CT imaging are undeniable, concerns about the associated radiation exposure have prompted the medical community to adopt measures aimed at optimizing radiation doses while maintaining diagnostic image quality **(2).** Diagnostic Reference Levels (DRLs) have emerged as a critical tool in this endeavor, serving as benchmarks to ensure that radiation doses from CT scans are kept within acceptable limits without compromising diagnostic efficacy **(3).**

The development and implementation of DRLs are essential components of a broader initiative to enhance patient safety in medical imaging. As ionizing radiation is an inherent part of CT imaging, concerns about its potential long-term effects have fueled the need for standardized guidelines that guide healthcare providers in achieving the delicate balance between obtaining clinically useful images and minimizing radiation exposure **(5, 6).** DRLs, defined as reference values for typical radiation doses in specific imaging procedures, play a pivotal role in achieving this balance by providing a yardstick against which institutions can compare and optimize their own radiation practices **(7).**

Head CT scans, in particular, play a pivotal role in the assessment of neurological conditions, trauma, and various cranial pathologies. As technology advances and imaging protocols evolve, the need to establish region-specific DRLs for head CT scans becomes imperative **(8).** DRLs are dose benchmarks that represent the upper limits of radiation exposure for specific medical imaging procedures, beyond which the risks of ionizing radiation may outweigh the diagnostic benefits **(9, 10).**

This research paper aims to address the critical gap in the current literature by undertaking a comprehensive analysis to establish Diagnostic Reference Levels specifically tailored for head CT scans. By synthesizing data from a diverse range of medical institutions, imaging centers, and patient populations, this study endeavors to provide a robust foundation for optimizing radiation doses in head CT imaging protocols.

PATIENTS AND METHODS

Ethical clearance was obtained from the Faculty of Medicine and Biomedical Sciences and the Directorate of Garoua Regional Hospital, as the information being gathered was keep anonymous prior to collection. Data was collected at the Regional Medical Imaging Center of the North. Radiation dose data were collected from the local CT scanners (GE REVOLUTION CT 65-slice, GE Healthineers, Europe -Central and Eastern) over a period of 12 months from January to December 2023. Some variable parameters considered in this study are: The patient age and sex, the Head CT indications, the Dose Length Product (DLP) in mGy·cm, the Volumetric CT Dose Index (CTDIvol) in mGy (milliGray), the voltage, rotation time and slice thickness. The data were collected for a period of 12 months and analyzed using Microsoft excel 2016 and SPSS software version 23. Quantitative data were analyzed using descriptive statistics. The dose quantities and gender population from each protocol were compared using independent sample t test. P less than 0.05 is considered significaly different.

The recommended Diagnostic Reference Levels for each protocol was the 75th percentile of the doses for this examination in the entire sample.Patients with Brain and cervical spine CT in a single acquisition, examination with 2 predefined protocols, discrepancies in Dose Data and incomplete information on PACS were excluded.

RESULTS

A total number of 621 Head CT scan examination was perform over a period of 12 month in our study, among which 295 were female and 326 male. We identify several head CT indications including: Acute Brain, Trauma, sinus, strokes, angiography and non-vascular brain scans.

Table 1: Distribution of patients according to age groups.

Age	Number of Patients	Frequency
18 -39	235	37.8
40 - 59	242	38.9
60 - 79	106	17.0
80 - 99	38	6.1
Total	621	100,00%

We can see from this table that the age group 40 to 59 was the most represented with a frequency of 38.9% while the group of more than eighty is the least represented with 6.1%

We can clearly see from this table and the stroke protocol was the most used one with trauma as indication with more than 27.2% of the Head CT examination. **(Table 2).**

Table 2: Head CT Protocol and indications related to the corresponding parameters

Protocol	Indication	Number of Patients	Percentage
Stroke	Trauma	169	27.2
	Post intervention	35	5.6
	Hemorrhage	19	3.0
	Neurological Onset	68	10.9
Non Vascular	Injection / abscess	42	6.7
	Metastasis	13	2.0
	Neoplasm	53	8.5
Sinus	Sinusitis	49	7.8
	Chronic Headache	91	14.6
	Nasal Obstruction	9	1.4
	Popyposis	53	8.5
Angiography	Cerebral Mass	12	1.9
	Ischemic Stroke	7	1.1
	AV Malformation	1	0.1
Total		621	100

Table 3: Head CT Protocol and indications related to the corresponding parameters.

Protocol	Indication	Voltage(Kv)	Current (mAs)	Pitch	Scan Length (cm)
Stroke	Trauma	120	265 (246-280)	0.52(5.52-0.52)	17.01 (16.86-17.60)
	Ischemic Stroke				
	Hemorrhagic stroke				
	Control				
	Hemorrhage				
	Neurological onset				
Non vascular	Infection	120	271 (253-291)	0.52(5.52-0.52)	16.71 (16.52-17.01)
	Metastasis				
	Neoplasms				
Sinus	Sinusitis	100	62 (49-64)	0.78 (0.78-0.78)	14.18 (14.02-14.81)
	Chronic Headache				
	Nasal Obstruction				
	Popyposis				
Angiography	Cerebral Mass	Phase 1:110	135 (131-150)	0.78 (0.78-0.78)	N/A
		Phase 2&3: 100	147(144-160)	0.78 (0.78-0.78)	
	Ischemic Stroke				
	AV Malformation				

Table 4: CTDIvol and DLP distributions statistics

Protocol	CTDIvol (mGy)			DLP (mGycm)		
	25th P	Median	75th P	25th P	Median	75th P
Stroke	37.6	38.9	42	592	626	692
Non Vascular	36.8	38.7	41	580	620	669
Sinus	4.7	5.0	5.3	65	72	78
Angiography	11.4	11.6	12.	277	299	320

Table 5: Comparing our result with Ugenda and Ireland

Protocol	Our Results		Uganda		Ireland	
	CTDIvol (mGy)	DLP (mGycm)	CTDIvol (mGy)	DLP (mGycm)	CTDIvol (mGy)	DLP (mGycm)
Stroke	39.9	675	39.1	629	38.8	626
Non Vascular	39.2	634	38.2	632	38.7	620
Sinus	5.7	81	5.2	78	4.9	72
Angiography	13.5	308	11.9	301	11.6	299

DISCUSSION

The results obtained from this study on Head CT Diagnostic Reference Levels (DRLs) yield valuable insights into the effectiveness of dose optimization strategies, the impact on patient safety, and the overall quality of medical imaging practices. Here, we delve into the key findings and implications of such research results: The study population consisted of 621 patients with a male predominance of 52.5%. These data are similar to those of E.Vano from Ireland also reported a male predominance of 58% **(6).** A comprehensive overview of 621 patients across various neurological indications. The largest category is Stroke, constituting 27.2% of cases, with Trauma being the predominant subtype at 27.2%. Post-intervention and Neurological Onset contribute 5.6% and 10.9%, respectively. Non-Vascular indications account for 17.2%, with Chronic Headache being the most prevalent at 14.6%. Sinus-related cases make up 22.3%, with Sinusitis and Chronic Headache being prominent **(11).** Angiography cases form 3.1%, with Cerebral Mass and Ischemic Stroke being the primary subtypes. This distribution highlights the diversity of neurological conditions, emphasizing the need for specialized diagnostic approaches and tally with the findings of Tan et al 2023 indicating that stroke was the most requested exam when it comes to head CT scan **(14).** Table 3 outlines imaging protocol parameters for various neurological indications. For stroke and trauma, a voltage of 120 Kv, variable current (265 mAs for trauma), pitch range (0.52), and scan length (17.01 cm) are specified. Non-vascular infection imaging employs similar parameters. Sinusitis imaging involves 100 Kv, 62 mAs, pitch 0.78, and scan length 14.18 cm. Angiography details different voltage and current settings for cerebral mass and ischemic stroke with a specified phase for AV malformation. The table 4 compares imaging results (CTDIvol and DLP) for different protocols between your facility, Uganda, and Ireland. In the Stroke protocol, our results are slightly higher CTDIvol (39.9 mGy) and DLP (675 mGycm) compared to Uganda (39.1 mGy, 629 mGycm) and Ireland (38.8 mGy, 626 mGycm). Similarly, in Non-Vascular and Sinus protocols, our CTDIvol and DLP values are slightly higher than both Uganda and Ireland **(12).** In Angiography, Our results also show slightly higher values. These comparisons provide insights into radiation exposure in different imaging protocols, indicating variations across locations and device used **(15).**

LIMITATIONS OF THE STUDY

This study was limited by the sample size and diversity of the participants. The data came from a specific healthcare center, potentially limiting the generalizability of the established DRLs to a broader population.

External factors, such as emergency situations or urgent clinical needs, might impact adherence to established DRLs. The study may not comprehensively account for these external variables that could influence radiation exposure levels in real-world scenarios

Long-term follow-up data on patients included in this study is lacking. Monitoring the health outcomes of individuals exposed to radiation over an extended period would provide a more comprehensive understanding of the impact of radiation exposure.

CONCLUSION

The determination of diagnostic reference levels (DRLs) for CT scans is a crucial aspect of dose optimization and quality assurance in medical imaging. DRLs are typically based on CTDI-based metrics such as CTDIw, CTDIvol, and DLP, and they serve as indicators for typical practice in a specific region or country. It is important to note that DRLs are not the suggested or ideal dose for a particular procedure, but rather represent the level at which an investigation of the appropriateness of the dose should be conducted. They are supplements to professional judgment and are intended to enable individual CT users and the community at large to identify and address consistently high doses. The process of determining DRLs involves the use of audit data, comparison of local and national DRLs, and the consideration of different calculation methods. However, there can be variability in DRLs due to the diversity of CT scanners and the methods used for their calculation. Therefore, ongoing assessment and review of DRLs, in conjunction with image quality assessment, are essential for ensuring patient doses are optimized and maintained within an acceptable range.

CONFLICT OF INTEREST

None

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