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Original Research Article

Improving Image Quality for Acute Ischemic Stroke and Transient Ischemic Attack Computed Tomography Imaging in Zambia

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Abstract: ***Introduction***: Rapid clinical and radiological evaluation provides the foundation for the immediate treatment of acute ischemic stroke (AIS) and transient ischemic attack (TIA), which are medical emergencies. In order to diagnose the etiology of AIS/TIA and aid establish the best course of treatment, there are international recommendations for performing head computed tomography (CT) scans. However, these researchers noticed that the radiographers, at the study sites in Zambia, employ the traditional plain pre-set brain CT scan imaging parameters. This research demonstrated the need to adjust these pre-set imaging parameters, so as to improve the resultant images. ***Aim***: The aim of this study was to improve CT image quality for AIS/TIA patients. ***Methods***: This study used a quantitative, comparative research design. The first step involved a quantitative, retrospective assessment of patient files to determine the current head CT scan parameters used in imaging patients with AIS/TIA. The reconstruction and implementation of the international criteria for the imaging of these patients constituted the subsequent prospective quantitative phase. Adjusted CT imaging parameters were applied after the retrospective and prospective data statistical analysis. The sample (N=202 images) was purposefully selected. ***Results***: The study improved the ability to enhance the contrast of diagnostic images at lower radiation dose index output. Following the intervention, the average image contrast increased from 4.28 to 5.22Hu (21.96% increase) and the CT dosage index output was reduced by 72.42%. ***Conclusion***: Our study has shown that the modified imaging system can be more effective than the traditional AIS/TIA imaging systems currently in use in Zambia

Keywords: Acute Ischemic Stroke, CT Dose Index, Computed Tomography, Stroke, Transient Ischemic Attack, Zambia.

INTRODUCTION

The World Health Organization (WHO) defines stroke as the abrupt onset of clinical symptoms linked to a localized, sometimes widespread disruption of brain function that lasts more than twenty-four hours. It can be fatal in adults and has no apparent etiology other than vascular origin (Bhat, Pasha, Kumar, 2022). In 2015, it was estimated to account for 42.4 million cases worldwide, and was described as one of the most prevalent causes of sensory impairment (Maceira P, *et al.*, 2019). In Africa; stroke has an annual incidence rate of up to 316 per 100,000, and a frequency of up to 1,460 per 100,000 (Akinyemi *et al.,* 2021). According to the WHO, stroke makes up 7% of adult diseases in Zambia. It represents 4.3% of all recorded deaths and is the fifth most common cause of death (Gwaba, Isaacs & Harneck, 2018).

A transient ischemic attack (TIA) is defined as a focal neurological impairment caused by ischemia that goes away in less than 24 hours. Timely treatment is essential to reduce the risk of a large stroke. A TIA may develop into a stroke if it is not adequately handled. AIS, on the other hand, happen when a blood artery in the brain or neck becomes clogged (Joannides *et al.*, 2022). Research conducted by several researchers has

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demonstrated that blockage of the blood and oxygen supply is the primary cause of brain cell death following AIS (Mendelson & Prabhakaran, 2021; Hui *et al.,* 2025; Akinyemi *et al*., 2021).

For AIS and TIA to be treated precisely, an accurate diagnosis is necessary. For clinicians, it is a practical challenge to comprehend the different parts of these imaging techniques, such as which ones to use and how best to do so given the resources available at their local institution. Time constraints, cost, accessibility to imaging modalities, the preferences of treating physicians, the availability of expertise, and the availability of endovascular therapy are all important considerations. Thus, adjusting the current CT imaging parameters can enhance the process of identifying the best course of treatment as well as the diagnosis of TIA and AIS.

There has been little attempt to improve the quality of CT imaging for AIS and TIA patients in Zambia. For instance, patients with suspected AIS should immediately receive non-contrast CT (NCCT) plus CT angiography (CTA) with or without perfusion CT or NCCT plus digital subtraction angiography for vascular assessment, according to the most recent American Heart Association/American Stroke Association guidelines (Wintermark *et al.*, 2013). But, specifically designed equipment to conduct CT perfusion and angiography and not readily available in Zambia.

In order to improve the contrast of the TIA/AIS CT images and conform to international clinical practice guidelines, this research aimed to improve image quality by standardising the order of acquisitions with their technical acquisition parameters (such as kVp, mAs, and slice thickness) across a wide range of AIS and TIA brain CT studies that are carried out on a daily basis. By following this recommendation, diagnosis will be enhanced, resulting in more rapid and effective responses.

METHODS

Study Design

A quantitative, descriptive comparative research methodology was used in this study (Lex, *et al*., 2010). This approach helped to describe the differences between independent variables, before and after reconstruction of CT images, and then use the findings to adjust the current TIA/AIS CT imaging parameters to ones that helped improve image quality. The results helped to identify the gaps in the current imaging practices and were then utilized to modify the existing TIA/AIS CT imaging parameters in order to enhance image quality. The design allowed the researcher to quantify the degree of CT imaging parameters that would yield CT dose index output and images of a particular quality.

In order to demonstrate correlation, the linear relationship between several continuous variables was found by analysing the associations between different CT imaging parameters and the image contrast. For example, this study demonstrated the relationship between the various imaging parameters (independent factors) and the image quality and CT radiation dosage output (dependent variables). Additionally, mean scores from different groups were compared across different research sites. As a result, this comparative study was able to show how different CT imaging parameters could produce different results in different contexts. Therefore, the aforementioned quantitative research used a two-tiered approach. The first tier involved the analysis of retrospective data while the prospective stage involved the application of new TIA/AIS CT imaging parameters. Lex, *et al*., 2010; Esser & Vliegenthart, 2017; Blair-Walcott, 2023; Siedlecki, 2020; Iranifard & Latifnejad Roudsari, 2022; Nunan, 1992).

Study Sights

This study was conducted at five public hospitals equipped with CT scanners. These are two hospitals in Lusaka, one on the Copperbelt, one in Eastern, and one in Southern provinces of Zambia. These sites represented the five provinces that had working CT scanners, at the time of the research.

Study Population and Sample Size

The purposefully selected population/units of analysis included file documents of adult males and females with AIS and TIA that underwent head CT scans from January 2019 to December 2023 from the five selected public hospitals. The files were for clients from all races, aged 20 years and above. This is so because, according to Katan and Luft, (2018) the incidence of stroke among adults aged above 20 years have increased by 25% worldwide in the preceding years. In Zambia, Nutakki *et al*., (2023) found that young adults (less than 50 years old) made up one-third of the Zambian stroke cohort. The selected files' CT images were then reported on by three qualified radiologists. Each patient's CT report was given a code and their information was kept confidential from all those who were not involved in this study.

The sample size for both the retrospective and prospective brain CT scan images of AIS and TIA patients was determined using the following formula, as adopted by Renjith *et al*., (2021).

$$\mathbf{n} = \frac{\mathbf{Z}^2(\mathbf{p} \times \mathbf{q})}{\mathbf{e}^2}$$

Where: **n** = sample size

Z = standard error associated with the chosen level of confidence (1.96)

p= estimated percentage of stroke fatalities in Zambia (7% as estimated for Zambia by WHO) (Katan & Luft, 2018)

q =100 – p

e = ± 5 acceptable sample error

$$\mathbf{n} = \frac{\mathbf{Z}^2(\mathbf{p} \times \mathbf{q})}{\mathbf{e}^2}$$

$$\mathbf{n} = \frac{1.96^2(7 \times 93)}{5^2}$$

$$\mathbf{n} = \frac{3.8416\ (651)}{25}$$

$$\mathbf{n} = 100.04$$

This study analysed 100 and 102 brain CT scan images for AIS and TIA patients for the first and second quantitative phases respectively. Therefore, in both phases of the investigation, a total of 202 CT brain raw data images were included.

Data Collection and Analysis

In Phase 1, files of TIA/AIS patients with images for patients that had a clinical diagnosis of TIA/AIS, based on clinical symptoms; were collected. These were reported on by the radiologists. In the prospective Phase 2, the radiologists from Phase 1 helped to reconstruct the same retrospective CT scan images and reported on them respectively. In Phase 3, the researcher tabulated the findings of Phase 1 and 2 for each set of CT images. With the help of the statistician, the researcher then determined if there was any change or difference in overall reporting output when using the reporting guideline (Furtado *et al*., 2010). In Phase 4, based on the results of the first three phases of this study and the available resources, a tailored CT imaging guideline was formulated. These imaging parameters were then used to capture images on eight patients and the images were sent to the radiologists and neurosurgeon to assess the image quality. These experts analysed the images and then completed a checklist, which is based on the standards set by the American College of Radiology, the Society of Neuro Interventional Surgery, and the American Society of Neuroradiology, (Wintermark, 2013) that helped determine the guidelines accuracy. All the expert colleagues also rated the impact of the new protocol, in terms of its impact in the management of stroke patients.

Ethics

Before conducting this research study, ethical approval was obtained from the Lusaka APEX Medical University ethics committee (Ethics reference: 00740-24). The various medical superintendents (at the study sites) in Zambia granted the researchers authorisation to begin the study. This study was conducted according to the Code of ethics of the World Medical Association (Declaration of Helsinki) (Blair & Blair, 2016; Arifin, 2018; Heale & Shorten, 2017)

Results

All the images used were routine non-contrast brain CTs (Helical) that followed the cranial, caudal direction while the patients were in supine position. 100 "Before reconstruction" and 102 "After reconstruction" CT images were selected from a variety of TIA and AIS patients at the five study sites. Of these, 118 (58%) were for females and 84 (42%) were men; 130 (64%) had AIS and 72 (36%) had TIA.

Table 1: Age distribution

	Age (years)	Frequency	%
Valid	Below 40	13	13
	40-49	15	15
	50-59	13	13
	60 - 69	16	16
	70- 79	34	34
	Above 80	9	9
	Total	**100**	**100.0**

Table 2: Descriptive analysis of age distribution in stroke

	Age (years)
Mean	59.9
Median	63.5
Mode	71
Std. Deviation	16.9
Variance	284.9
Range	60
Minimum	29
Maximum	89

Tables 1 and 2 show that the population's age distribution was older, with the majority of participants falling between the ages of 70 and 79. The standard deviation and variance show how the ages of the patients differed from each other and from the mean, respectively.

Phase 1 Imaging Parameters

Table 3 displays different imaging parameters (input) and findings (output) for each of the five research sites. The necessity for the adjusting the imaging parameters of AIS and TIA, CT imaging, across various sites and scanner manufacturers was validated, given the various imaging parameters employed to provide images of varying quality and CT dosage index output.

Table 3: Imaging parameters and output before Intervention, across study sites

Variable	Site 1 N44 (21.78%)	Site 2 N=28 (13.86%)	Site 3 N=86 (42.57%)	Site 4 N=18 (8.91%)	Site5 N=26 (12.87%)
CT dose index (mGy)	48.54(±0.00)	76.14(±0.00)	34.28(±0.00)	76.14(±0.00)	45.7(±0.00)
MAS	350(±0.00)	471(±0.00)	240(±0.00)	471(±0.00)	300(±0.00)
Window Level	50(±0.00)	40(±0.00)	40(±0.00)	40(±0.00)	40(±0.00)
Window Width	150(±0.00)	85(±0.00)	100(±0.00)	85(±0.00)	100(±0.00)
Contrast	2.22(±3.35)	5.93(±4.66)	4.69(±3.87)	4(±2.78)	4.69(±3.85)
Slice Thickness	5(±0.00)	5(±0.00)	3(±0.30)	5(±0.00)	5(±0.00)
Kv	120(±0.00)	120(±0.00)	120(±0.00)	120(±0.00)	120(±0.00)

Table 4 shows the mean exposure factors used (Kv, mAs, WW, WL and slice thickness) at the study sites.

Table 4: Parameter Baseline Characteristics

Variable	Mean(N=202)	(±SD)
Exposure Factor Used(KV)	120	(±0.00)
Exposure Factor Used (mAs)	324.28	(±90.48)
Window Width (Hu)	101.01	(±20.39)
Window Level (Hu)	40.86	(±3.36)
Slice Thickness (mm)	3.14	(±1.41)
CT dose index (mGy)	62.61	(±16.06)
Image contrast	4.74	(±4.28)

Phase 2 Data Output

The images were reconstructed in terms of slice thickness, window width, and window level using the same retrospective CT raw data. Iterative model reconstruction was the analytical reconstruction method used (Southard *et al*., 2019).

Table 5: Imaging parameters and output after Intervention

Variable	After Intervention
CT dose index (mGy)	62.61(±16.08)
Window Width	94.65(±14.41)
Window Length	39.55(±0.14)
mAs	325(±91.41)
Image contrast	5.22(±0.46)
Slice Thickness	2.14(±0.99)
Kv	120(±0.00)

Phase 3

In order to evaluate the effect of reconstructing imaging parameters, phase 3 of this study compared the results from phases 1 and 2.

Table 6: Bivariate Analysis of Parameters by Patient Groupings

Variable	Before Intervention	[95% CI]	After Intervention	[95% CI]	P-value
Radiation Emitted	62.62(±1.61)	(59.41,65.8)	62.61(±16.08)	(59.45,65.77)	0.499^{z}
Window Width	107(±23.34)	(102,110.3)	94.65(±14.41)	(90.7,96.1)	0.042^{z}
Window Level	42.15(±0.40)	(41.34,42.96)	39.55(±0.14)	(39.2,39.8)	$<0.001^{*z}$
mAs	325.7(±91.41)	(245.3,453)	325.7(±91.41)	(245.3,453)	0.572^{z}
Contrast	4.28(±0.38)	(4.51,5.05)	5.22(±0.46)	(4.30,6.13)	0.040^{z}
Slice Thickness	4.13(±0.99)	(3.94,4.33)	2.14(±0.99)	(1.94,2.33)	$<0.001^{*z}$

Note: z=z-test, *=statistically significant p-value is <0.05

After the intervention, a number of imaging parameters showed substantial alterations, according to the bivariate analysis. Following the intervention, the mean WL decreased from 42.15 (SD ±0.40) to 39.55 (SD ±0.14) (6.17%) (p-value < 0.001), and the WW decreased from 107 (±23.34) to 94.65 (±14.41) (11.54%), p=0.042. Similarly, the slice thickness decreased from 4.13 mm (SD ±0.99) prior to reconstruction to 2.14 mm (SD ±0.99) (48.18%) during reconstruction (p-value < 0.001).

The contrast between the two periods was improved in terms of overall image quality. The contrast of the images before and after reconstruction was 4.28 (SD±0.38) and 5.22 (±0.46), respectively, showing an increase of 21.96%, p=0.040. This suggests that the reconstruction was successful in improving imaging quality and improving diagnostic results.

The radiation output remained unchanged, with mean values of 62.62 (±1.61) before and 62.61 (±16.08) after the reconstruction, which was statistically significant at p=0.4. This lack of change indicates that although some parts of the imaging protocol were altered, the primary determinants of radiation exposure, kV and mAs, did not change between the before and after reconstruction images.

The imaging parameters (mAs, WW, WL, slice thickness) and average contrast value and radiation outputs were correlated using Pearson's linear correlation coefficient. According to table 7, results were deemed significant when the p value was less than 0.05.

Table 7: Correlation between CT imaging parameters and output scores

Pearson Correlation		**CONTRAST**	**WW (p value)**
Pearson Correlation		**Contrast**	**Slice thickness**
	Contrast	1	-0.189(0.007)
	Slice thickness	-0.189(p=0.007)	1
Pearson Correlation		**Contrast**	**WW**
	Contrast	1	-0.262(0.0002)
	WW	-0.262(0.0002)	1
Pearson Correlation		**Contrast**	**WL**
	Contrast	1	-0.174(0.013)
	WL	-0.174(0.013)	1
Pearson Correlation		**Radiation dose output**	**mAs**
	Radiation emitted	1	0.995(0.0001)
	mAs	0.995(0.001)	1

Phase 4

In the fourth phase of the study, imaging parameters were adjusted based on the alterations that each imaging parameter was found to generate in phase three. These imaging parameters were selected based on our TIA and AIS CT imaging experience, the review of prior research, and the identified changes that each imaging parameter would generate as demonstrated in phase 3. As a result, table 8 presents the suggested imaging parameters for CT imaging in patients with TIA and AIS in Zambia, following careful evaluation of the technology and resources available. These imaging parameters were then applied on eight patients (figure 1). This aided in confirming that, given the resources at hand and the knowledge gained from the previous three stages, these imaging parameters would yield the best images at the lowest possible CT radiation index output.

Table 8: AIS/TIA CT imaging protocol

Clinical indication	**Suggested protocol**
AIS/TIA patient position	Helical scans with patient in supine, arms besides the body
Suspected AIS/TIA to rule out ischemia	Non-contrast CT brain with parameters within a WL range of between 30 to 41HU and WW range of 40 to 80HU. 3mm slice thickness, 260mAs and 120kV
Suspected AIS/TIA for thrombus assessment	Non-contrast CT brain with parameters set at WL=31, WW=66, 3 mm slice thickness, 260mAs and 120kV
Suspected TIA/AIS for thrombus assessment/measurement, stenosis, plague	Contrast CT brain and neck with parameters set at WL=31, WW=66, 3mm slice thickness, 260mAs and 120kV
All suspected TIA/AIS	Reconstructed using iterative, axial and coronal images, 1mm thin slice

Images obtained, using the above imaging parameters are shown in figure 1.

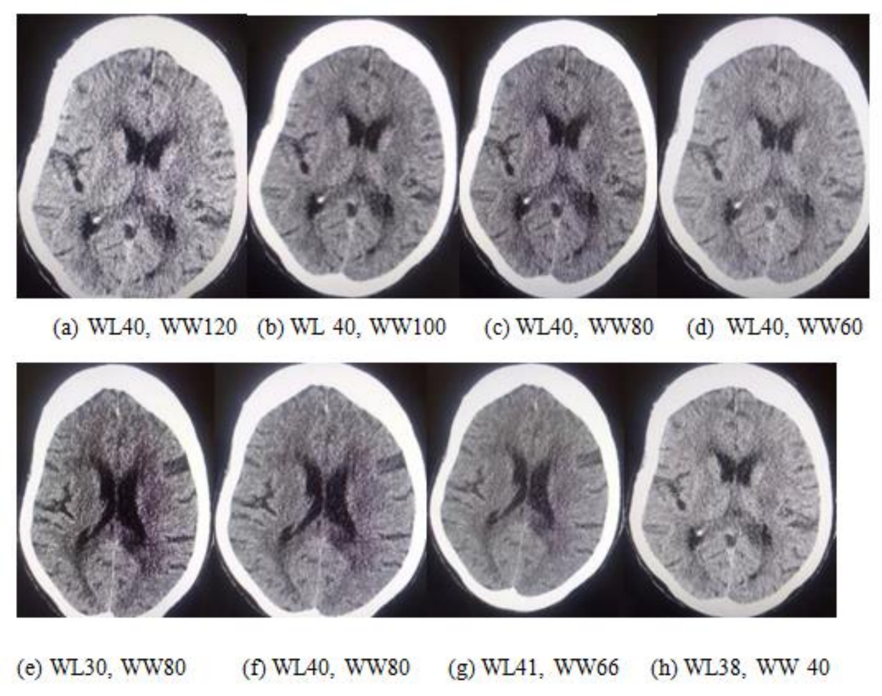

Figure 1: Different image qualities obtained using the above imaging parameters, using different WL and WW at 3mm slice thickness, 260mAs and 120kV

From the above images, the best images were acquired between a range of WL=30 to 41 and WW=40 to 80 (images e, f, g, h). However, specifically, the best image were acquired at WL=41 and WW=66 for the best thrombotic clots occluding cerebral arteries detection and measurement (without contrast), and WL38 and WW 40 (with/without contrast) as it is able to show the best grey-white matter differentiation in infarct detection.

The findings of the subjective judgement show that the three radiologists, six CT scan radiographers as well as the two neurologists did not disagree. The image qualities and ability to enhance management were rated as excellent, for these images, by all the radiologists, CT scan radiographers and neurologists, used in this study. This was done by the use of a three-point rating system to assess the image quality of each intracranial vessel as: 0 to 2 (2=excellent, 1=good, 0=non-diagnostic) (Furtado *et al.,* 2010). If small ischemic changes and intracranial vessels are diagnostic 2 is allocated, if one segment is diagnostic 1 is allocated and 0 if no segments is diagnostic (Furtado *et al*., 2010).

Discussion

The most important finding of this study is that the manufacturers' pre-set CT imaging parameters, for TIA/AIS patients can be adjusted, so as to improve image quality.

Statistical analysis of data revealed that CT image quality could be improved by adjusting certain imaging parameters across the study sites. Significantly, this study revealed that by dropping the mean WL from 42.15 (SD ±0.40) to 39.55 (SD ±0.14), p-value < 0.001 (a decrease of 6.17%), and the mean WW from 107 (±23.34) to 94.65 (±14.41), p=0.042 (a decrease of 11.54%), image quality would be enhanced. These changes showed a weak negative correlation between the WW and WL changes and image contrast, with r=-0.262 (p=0.0002) and r=-0.174 (p=0.0001), respectively. The average image contrast increased from 4.28 to 5.22HU (21.96% increase) following the reconstruction. This resulted from the decrease in WW and WL, which enhanced signal clarity and reduced image noise (Viriyavisuthisakul *et al*., 2020; Viriyavisuthisakul *et al*., 2023) proving that modifying imaging parameters improves image output. According to Jung (2021), CT images can be displayed at different brightness and contrast levels by adjusting the WL and WW. Widowing allows for the effective display of tissue with similar tissue densities, such as the brain, at narrow WW and WL and highlights certain anatomical or pathological features in the image. Therefore, Viriyavisuthisakul *et al*., (2020) have explained that diagnostic and patient care modifications result from minor adjustments to image quality, which justifies the windowing adjustments in this study, despite the minor negative connection between windowing and image contrast.

Similarly, after reconstruction, the average slice thickness was decreased from a mean of 4.13 mm (SD ±0.99) to 2.14 mm (SD ±0.99), with a p-value < 0.001 (48.18% decrease). This reduction had the effect of enhancing the detecting of small or mild brain lesions and improving spatial resolution in TIA/AIS imaging. Anatomical detail and diagnosis accuracy were enhanced by thinner-sliced, higher-resolution images, (Jung, 2021;

Huang *et al.,* 2021). This is particularly important in resource-constrained settings like ours, where it may be challenging to perform contrast enhanced angiography due to insufficient CT consumables (like contrast media) or equipment limitations (like CT angiography and CT perfusion). The test results showed that adjusting a combination of slice thickness, WW, and WL decrease improved image contrast.

In this study, the various study sites showed a strong positive correlation (r=0.995), that was statistically significant at p=0.0001, between the dose radiation index output and mAs. Increases in tube current have been shown by several researchers (Wolbars *et al*., 2012; Stoyanov & · Vassileva, 2010) to lead to higher patient doses, better image clarity, and reduced image noise. The kVp was consistent at 120kVp at every study site. Changes in tube voltage can affect patients' contrast, noise, and dose by changing how certain materials are absorbed (Tack &. Kalra, 2012).

Based on these findings, the imaging parameters were modified (table 8) and implemented based on the image quality improvements as determined in phases one to three. Since the kVp was similar at all the study sites, a Kvp of 120 was maintained. This is similar to the American Association of Physicists in Medicine (Takagi *et al*., 2021) recommended tube voltage of 120–240 kV.

A tube current and exposure duration product of 260 mAs was selected, based on our clinical experience and a review of the literature. Comparing this mAs to the higher mAs currently in use at the research sites revealed no losses in the delineation of ischemia lesions/quality. A research by Bodelle *et al*., (2015)[2] found that brain images taken at this current were exposed to a radiation dose of 1.77 mSv instead of 2.33 mSv; p<0.01 obtained at the normal 340 mAs, representing a dose decrease of 24.03%, and that there was no compromise in image quality. Compared to our research sites, particularly hospitals like site 2 and site 4, which are currently employing a high of 471mAs, patients assessed with a 260-mAs low-dose in this study are exposed to a statistically considerably lower dose. When combined with our other imaging settings, this mAs considerably decreased the CT radiation dose index output by 72.42%, p=0.01.

The slice thickness was set at 3 mm and then iteratively reconstructed to a thickness of 1 mm. Because partial volume affects cause artefacts in large slice thicknesses, this reduced slice thickness improves the spatial resolution (European Commission, 2015). A thrombus can be identified in AIS/TIA non-contrast CT imaging using the aforementioned slice thickness and iterative reconstruction of 1 mm slice thickness; clot loads that could not be evaluated in the existing 5 mm slice thickness scans at the research sites. According to researchers such as Riedel *et al*., (2010) intravascular thrombus can be measured using such a high spatial resolution. These imaging characteristics should be taken into account since CT plaque measures can be used as a marker of therapy response and to guide medical care, in line with the findings of other researchers (Wolbarst *et al*., 2012).

In this study, window levels are adjusted to compensate for any contrast resolution loss resulting from the thin slice selection. Research by Khobragade *et al*., (2017) is in line with our finding. These researchers explain that WL alteration of CT images is frequently employed to enhance visibility in the clinical context. In this study, we set the WL range to between 30 and 41 HU and WW range of between 40 to 80 HU. At this setting, the sensitivity to detect AIS/TIA is enhanced and is different from the standard brain window setting of WL=20 and WW=80HU recommended by the American College of Radiology (Potter *et al*., 2019). This image contrast is higher (p=0.013) at this range of WL and (p=0.0002) at this range of WW than our existing imaging settings at the five research locations. Additionally, our findings differ from those of previous researchers (Muqmiroh *et al*., 2018) who proposed that the 35 WW 25 WL configurations would enhance the diagnostic value of the sub-acute stroke infarct. In contrast to our imaging advice, Czap *et al.,* (2021) utilized a WW and WL of 40/40, whereas other investigations by Byrne *et al*., (2020) employed a WL in the range of 8 to 40 and WW of 32 to 40; indicating that different windowing levels are currently utilized across different settings.

The three radiologists and two neurologists utilized in this investigation regarded the images produced by the aforementioned imaging parameters as excellent. The three radiologists, two neurologists, and six radiographers utilized in this study regarded the capacity to improve TIA/AIS management using these images as excellent. They all agreed that the altered imaging parameters demonstrate a significant improvement from current practice.

CONCLUSION

This study has shown that modifying pre-set manufacturer brain CT imaging parameters can enhance image quality while performing CT imaging for AIS/TIA patients. The results have helped us, in our local setting, to employ particular imaging parameters designed for TIA/AIS patients in an effort to improve patient outcomes, optimize resource allocation, and improve diagnosis accuracy. These imaging parameters have improved our ability to identify thrombus and minor artefacts on non-contrast CT scans at reduced radiation dose index output.

RECOMMENDATION

In our resource-constrained setting, it is advised that CT scan radiographers, radiologists, and attending physicians use these CT scan imaging parameters as a reference when imaging TIA/AIS patients.

It is advised to conduct additional collaborative studies with specialists from other nations with comparable resource constraints.

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