JURNAL KESEHATAN
JK
Published by
Center for Research and Community Service
Poltekkes Kemenkes Tanjung Karang

Jurnal Kesehatan
Volume 17, Number 1, April 2026
ISSN 2086-7751 (*Print*), ISSN 2548-5695 (*Online*)
http://ejurnal.poltekkes-tjk.ac.id/index.php/JK

Differences in Image Information on Abdominal CT Scan with Clinical Intra-Abdominal Tumors Between Variations in ASiR-V 60%, 70%, and 80%

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ARTICLE INFO

Article history

Submitted:
27 February 2026

Revised:
2 April 2026

Accepted:
16 April 2026

Keywords*:*

Anatomy;
Image Quality;
Signal-to-Noise Ratio.

ABSTRACT

Previous studies have shown that an ASiR-V rate of 60% is optimal for contrast-enhanced abdominal CT scans in patients with kidney stones. In this study, however, the ASiR-V variations tested were 60%, 70%, and 80%, with a focus on clinical intra-abdominal tumors. The objective was to measure the optimal signal-to-noise ratio (SNR) and contrast-to-noise ratio (CNR) values for CT images of these tumors. The research employed a quantitative retrospective experimental design with a sample of 10 patients who met the inclusion criteria. The findings reveal notable differences in SNR, CNR, and Hounsfield Unit (HU) values across the ASiR-V variations, with the 70% ASiR-V showing the highest values for both SNR and CNR.

INTRODUCTION

CT-Scan is the main modality for visualizing malignancy in the abdomen because its images have high spatial resolution and relatively fast acquisition time, which can reduce artifacts from peristaltic motion (Haaga & Forsting, 2017). In the abdominal area, the small density difference in soft tissue results in low photon absorption by the detector, increasing noise (Lee & Kim, 2018). The statistical iterative reconstruction (ASiR-V) algorithm in GE Healthcare's CT-Scan is a hybrid reconstruction method that reduces statistical noise from photons and electrons, thereby improving image quality.

The under-studied variation in ASiR-V values is multiples of 10, such as 60%, 70%, and 80%, especially in the context of intra-abdominal tumors. Several studies on optimal dosage and iterative reconstruction of abdominal CT scans compared presentations with multiples of 20, such as 40%, 60%, and 80%. The literature testing the ASiR-V value of 70% as the midpoint between 60% and 80% remains limited. In addition, evaluating intra-abdominal tumors requires high contrast resolution to distinguish lesions from healthy tissue.

ASIR was developed using an algorithm that estimates X-ray photon statistics, which are typically less accurate than those obtained with FBP. To minimize reconstruction time, ASIR incorporates information from images reconstructed by FBP as a foundational element in the reconstruction process. This approach allows for various adjustment levels, including 0%, 10%, 20%, 30%, 40%, 50%, 60%, 70%, 80%, 90%, and 100%.

Some findings suggest that an ASiR-V level of 60% is optimal for non-contrast abdominal

CT scans in urolithiasis cases, though the study's retrospective design and reliance on a single GE Optima 660 128-slice model limit generalizability (Pratama et al., 2020). Research by Zhu et al. (2021) and Ungania et al. (2023) indicates improved image quality at mid- to high ASiR-V levels, but they did not evaluate oncological lesions. Caruso et al. (2021) and Zhong et al. (2024) noted that ASiR-V rates of 60%-80% can stabilize radiomic features, but their studies were limited to non-specific populations. ASiR-V reduces noise in low-dose imagery while maintaining image quality, but its findings are limited to the lungs and the abdomen-pelvis (Choopani et al., 2023).

The Hounsfield Unit (HU) is a key parameter in CT imaging that reflects tissue X-ray attenuation and enables quantitative image assessment. HU values are essential for tissue differentiation, lesion characterization, and evaluation of image quality metrics such as SNR and CNR, thereby improving diagnostic accuracy (Kalender, 2022). The research (Goodenberger, 2018) reported that HU values remain stable with ASiR-V use, while higher ASiR-V levels reduce noise. However, the study did not assess various tissues and pathologies, limiting the generalizability of its findings.

Based on the above research study, this study was made to measure the value of the SNR/CNR of the Abdomen MSCT Scan image at the variation of the ASiR-V value of 60%, 70% and 80%, give a subjective value to the information or anatomical details in the Abdomen MSCT image by the Radiologist, and help find the optimal ASiR-V value for Abdomen MSCT imaging with Clinical Intra-Abdomen Tumor. After the author knows the comparison of the optimal ASiR-V value variation, this can be implemented in clinical practice which is the following benefit of developing knowledge of image reconstruction techniques, especially ASiR-V, the results of this study can be used as a reference for future research, providing quantitative data on the application of ASiR-V value variations to CNR/SNR values in Abdomen MSCT images, providing optimal anatomical details to produce high diagnostic value, providing diagnostic services by implementing the ALARA (As Low As Reasonably Achievable) principle. This study aims to evaluate SNR and CNR values and assess anatomical image quality in abdominal MSCT using ASiR-V at 60%, 70%, and 80% to determine the optimal reconstruction value in intra-abdominal tumor cases. There is a significant difference in image quality among ASiR-V variations, with 60% expected to provide the most optimal balance between noise reduction and anatomical detail.

METHOD

The method used for this study is a quantitative retrospective experimental quantitative analysis with an experimental approach to analyze the difference in variation in ASiR-V values on image quality and image information from abdominal CT Scan examination with intra-abdominal tumor clinics from November to December 2025 at Sultan Agung Islamic Hospital, Semarang. The data collection in this study has received approval from the hospital with letter number 5597/B/RSI-SA/XI/2025 and received Ethical Clearance as a statement of ethical worthiness.

The population in this study was retrospective data of Abdomen CT Scan patients with an intra- abdominal tumor diagnosis during the study period. Data were collected using purposive sampling. The sample consisted of 10 patients who met the inclusion criteria. CT imaging was performed using a 128-slice GE Optima CT660 with 120 kV and 180 kV, 10 mm slice thickness, and an abdominal window width, and reconstructed with 3 ASiR-V values of 60%, 70%, and 80%. Image quality is assessed using the IndoQCT application, which analyzes CT-Scan images, including SNR, CNR, and HU Values. Meanwhile, CT scan images are evaluated subjectively using Radiant Viewer by Radiologists and Radiographers with relevant work experience.

Image reconstruction

The reconstructed images were based on 10 abdominal CT scans of patients who met the inclusion criteria. The raw data were then reconstructed using ASiR-V values varying by 60%, 70%, and 80%. The CT scan images of patients who have been reconstructed using variations in ASiR-V values of 60%, 70%, and 80% is transferred to a compact disc (CD) as a medium to transfer to a laptop. Furthermore, the CT scan images were analyzed using the IndoQCT application to assess image quality parameters, including Signal-to-Noise Ratio (SNR), Contrast-to-Noise Ratio (CNR), and CT Number HU Accuracy. Subjective assessment of anatomical structure by 2 Radiologists and 1 Radiographer using the RadiAnt DICOM Viewer 64-bit application, which scored based on the clarity of the anatomical structure of the image. The anatomy evaluated included right and left lobe hepa, hepatic periphery boundary, gallbladder, spleen, gaster, aorta, hepatic artery, portal vein, renal, psoas muscle, subcutaneous fat, urinary vesicles, rectum, uterus for female patients and prostate for male patients, hepatic mass, gaster mass, left renal mass, aortic mass, pelvic cavum mass, uterine mass, uterus, nodules on the hepa, nodules on the spleen, and thickening on the VU wall. This method is carried out systematically to produce test data for the evaluation of image quality and anatomical information at ASiR-V values of 60%, 70%, and 80%.

Image quality measurement (SNR and CNR)

Images of abdominal CT scan patients with an intra-abdominal tumor diagnosis were opened and calculated using the IndoQCT application. The first step is to select the Low Contrast Detectability menu, select CNR, and use the manual method (Samudra et al., 2025). After that, place the Object ROI and Background ROI at a size of 6 pixels (px) on each anatomy to be evaluated (Noveranty et al. 2024). The Object's ROI is placed on the anatomy to be calculated, while the Background ROI is placed on the background of that anatomy. Click calculate to generate a calculation of the SNR and CNR values that will be displayed in the app. Perform the method consistently in 10 patients with ASiR-V values varying by 60%, 70%, and 80%. The most widely used quantitative method for calculating SNR is the mean value (HU) of the network ROI divided by the Standard Deviation (SD) of HU at the same ROI (Flower, 2012):

$$SNR = \frac{ROI\ Organ}{SD\ Background}$$

Moreover, the quantitative method for measuring CNR is the sum of the mean value of HounsField (HU) Object ROI and the Background ROI divided by the standard deviation (SD) of the Background ROI on a homogeneous network (Bushberg et al., 2012):

$$CNR = \frac{ROIorgan - ROIbackground}{SDbackground}$$

CT number HU accuracy

The measurement of the HU unit uses the IndoQCT application by making an ROI ellipse with a size of 6 pixels, then placing it on the anatomy to determine the HU value, resulting in values from MEAN HU, MIN HU, MAX HU, and SD HU. Do it repeatedly for the rest of the anatomy. The Hounsfield unit is also called the CT-Scan unit, which is calculated from a linear transformation and the basic linear attenuation coefficient of X-rays. Hounsfield units can be calculated using the formula (μ) (Bushberg et al., 2012):

$$HU = 1000 \times \frac{\mu tissue - \mu water}{\mu water}$$

Assessment of anatomical information

Analysis of anatomical differences from CT scans in intra-abdominal tumors with ASiR-V values of 60%, 70%, and 80% was performed subjectively. In this study, two Radiologists and 1 radiographer assessed the patient's abdominal CT images directly in the 64-bit RadiAnt DICOM Viewer, which displayed 3 images with ASiR-V values of 60%, 70%, and 80%. Assessment is carried out subjectively at level 1; does not need to be assessed; 2 is unclear; 3 is less obvious; 4 is clear; and 5 is very clear. The five scores above will be applied to 3 ASiR-V values of 60%, 70%, and 80%.

Table 1. Assessment of anatomical information of abdomen CTScan in intra-abdominal tumors

Score	Definition	Information
1	No need to be assessed	Such anatomy does not need a value
2	Unclear	Anatomy is invisible; anatomical boundaries with each other are not visible
3	Less obvious	Anatomy can be assessed, but the bite is unclear
4	Clear	Anatomy can be assessed, and anatomical boundaries are visible
5	Very clear	Anatomy can be judged, and the anatomical boundaries of each other are very noticeable.

Data analysis

SNR and CNR data were analyzed using statistical applications. The Shapiro–Wilk test indicated that the data were normally distributed ($p < 0.05$). Furthermore, Levene's test for variance homogeneity indicated homogeneous data ($p < 0.05$). Therefore, the analysis continued with One-Way ANOVA at the significance level $\alpha = 0.05$. The HU accuracy analysis was conducted using the Kruskal–Wallis test because the data were not normally distributed. Two radiologists and one radiographer carried out a subjective assessment of image quality. The Friedman test is used because the data are ordinal (Likert), paired, and repeated-measure.

Assessment of image information on the Abdomen CT Scan examination for clinical intra-abdominal tumors was carried out by 2 radiologists and 1 radiographer as observers. To analyze agreement between observers, the Friedman Test is used. This test was conducted to compare three or more groups of data measured repeatedly. Because the dependent variables were assessed using a Likert scale, the data were numerical, included 3 paired groups, and involved repeated measurements on the same subjects.

RESULTS

Image quality difference (SNR)

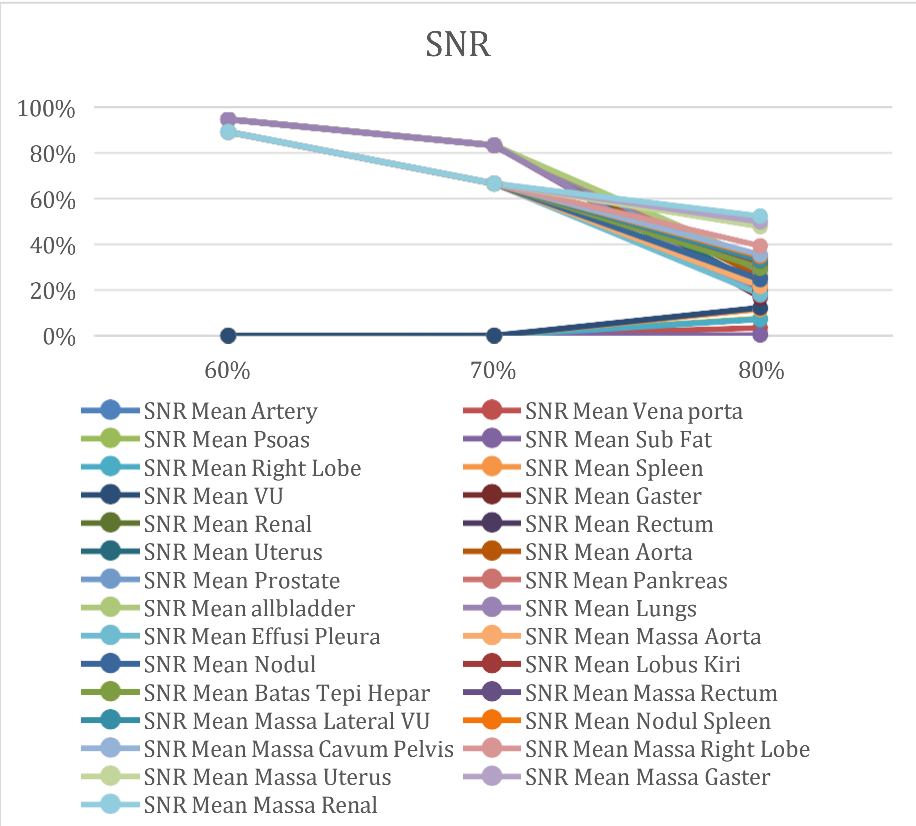

Figure 1. Mean rank of each ANOVA one-way test anatomy

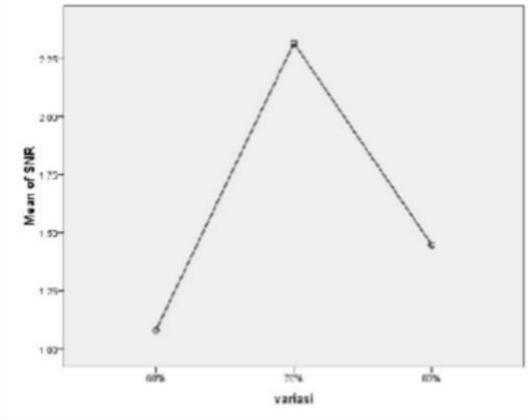

Figure 2. Results mean the overall rank of the ANOVA one-way test

ASiR-V 60% showed the highest SNR value in almost all parameters with the presence of noise but not significantly reducing the signal ratio, such as in the hepatic organs, kidneys, pancreas, spleen, portal veins, hepatic arteries, aorta, stomach, urinary vesicles, rectum, hepatic mass, renal mass, and nodules. ASiR-V 70% experienced a reduction in noise in each anatomy. Moreover, the image on ASiR-V 80% shows very consistent noise reduction, making the image smoother, but the signal decreases.

The average for each anatomy shows a decrease in the Signal-to-Noise Ratio (SNR) in line with the ASiR-V values of 80%, 70%, and 60%. The overall average calculation shows that the 70% ASiR-V variation has the highest average rating, followed by 80% ASiR-V, and 60% ASiR-V has the lowest average rating.

Image quality difference (CNR)

The 60% ASiR-V variation had the lowest SNR across anatomy, indicating that noise reduction was not entirely effective; the image still looked rough, and the boundary between organs and soft tissues remained visible. The 70% ASiR-V variation has a significant improvement over the 60% ASiR-V in almost the entire anatomy, resulting in fairly good noise, clearer anatomical details, and no oversmoothing. Meanwhile, ASiR-V 80% showed the highest values in most anatomies, where noise reduction was maximal, the image appeared smoother and more homogeneous, but overshooting occurred in some soft tissues. The 70% ASiR-V variation had a medium mean rank, providing the optimal balance, especially for contrast and noise in some of the anatomy and abdominal masses evaluated.

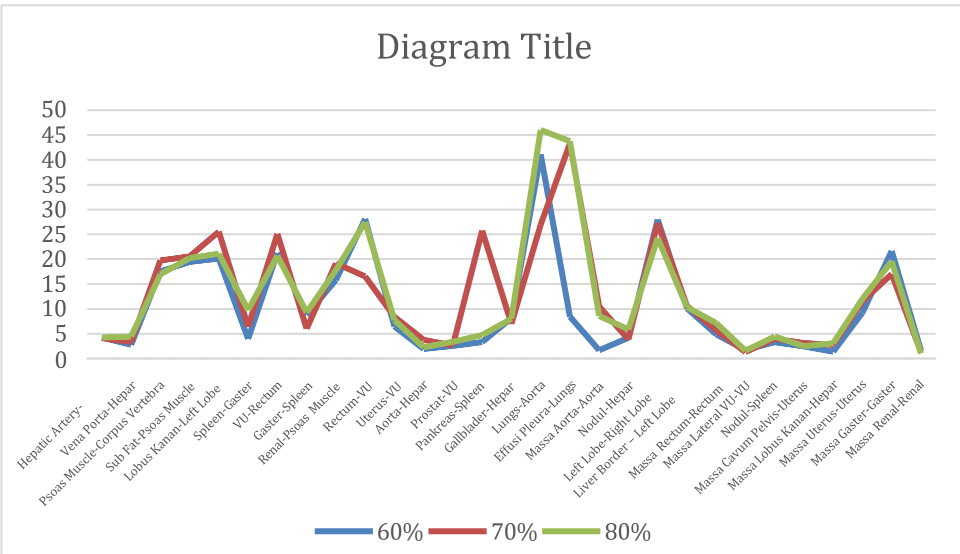

Figure 3. Mean rank of each ANOVA one-way test anatomy

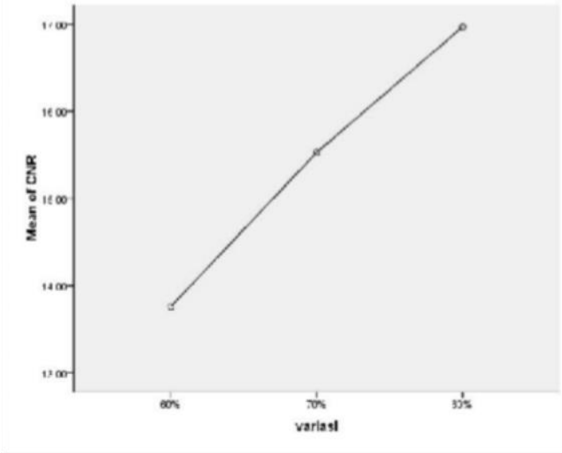

Figure 4. Overall mean rank results of the ANOVA one-way test

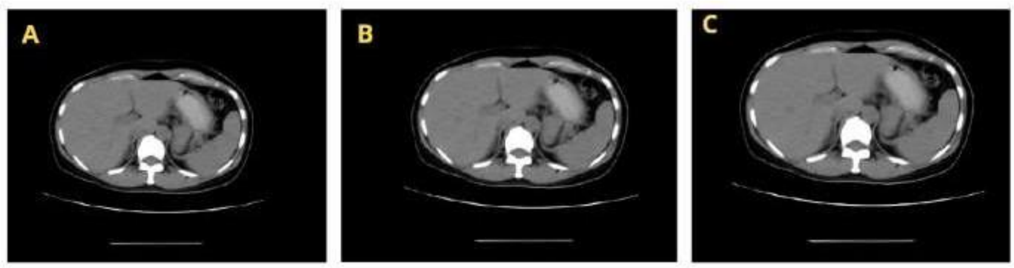

Figure 5. Abdomen CT scan with clinical intra-abdomen tumor (A); Using 60% ASiR-V value variation; (B) Using 70% ASiR-V value variation; (C) Using 80% ASiR-V value variation

CT number HU accuracy difference

The results of this statistical test showed that the p-value > 0.05 showed no difference between MEAN HU, MIN HU, and MAX HU within the group tested. Meanwhile, in SD HU, p<0.05, indicating a difference in the group being tested.

Table 2 shows that the highest mean ranks are for SD HU 60% and noise at ASiR-V 60%, both of which have higher values because their ability to reduce noise is not better than ASiR 80% and 70%.

Table 2. Results of Kruskal-Wallis Statistical Test CT Number HU Accuracy

Eruption	Variations			Total
	60%	70%	80%	
MEAN HU	274.81	271.35	269.84	543
MIN HU	268.90	270.28	276.81	543
MAX HU	285.19	267.85	262.97	543
S.S.	306.29	272.10	236.30	542

Anatomical information

In the assessment of anatomical information carried out by 2 radiologists and 1 radiographer, by filling out a questionnaire for each anatomy. This research questionnaire has 5 scales: 1, 2, 3, 4, and 5. Value 1 states "does not need to be assessed", value 2 states "unclear", value 3 states "less clear", value 4 states "clear", and value 5 states "very clear". After obtaining scores from 2 radiologists and 1 radiographer, the scores were tested using an inter-rater test to assess agreement, and the highest score was set. By the way, the scores are summed and then divided by 3, based on the number of observers. The variation with the highest score is the best. To strengthen the decision among observers, a Friedman statistical test was conducted, which indicated that there was no difference among the three observers.

Table 3. Mean rank Friedman test

Mean rank	
Variation 1	2.08
Variation 2	1.92
Variation 3	2.00

Table 4. Inter-Rater Test Results

Variations	Average Quality	Average
60%	244	81.3
70%	240	80
80%	221	73

Table 4 shows the number of 3 observers who assessed the image information for each variation in the ASiR-V value, with the highest score at 60%.

Figure 6. Lung anatomy information using (A) 60% ASiR variation; (B) 70% ASiR variation; and (C) 80% ASiR variation

Figure 7. Anatomical information of the hepar, abdominal aorta, gaster, and spleen using (A) 60% ASiR variation; (B) 70% ASiR variation; and (C) 80% ASiR variation

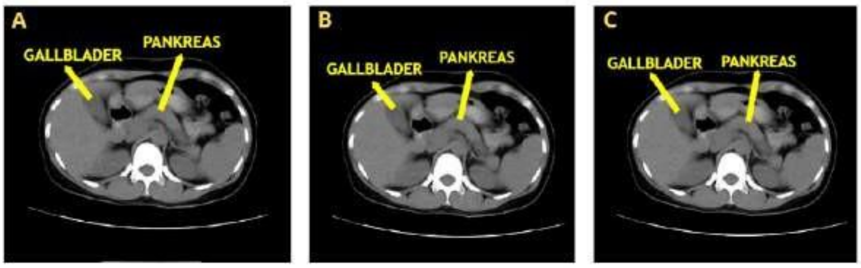

Figure 8. Anatomical information of the gallbladder and pancreas using (A) 60% ASiR variation; (B) 70% ASiR variation; and (C) 80% ASiR variation

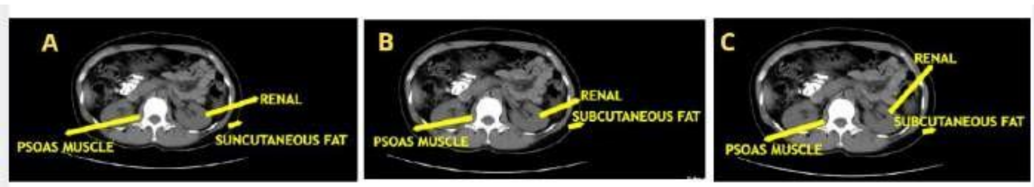

Figure 9. Renal, psoas muscle, and subcutaneous fat anatomy information using (A) 60% ASiR variation; (B) 70% ASiR variation; and (C) 80% ASiR Variation

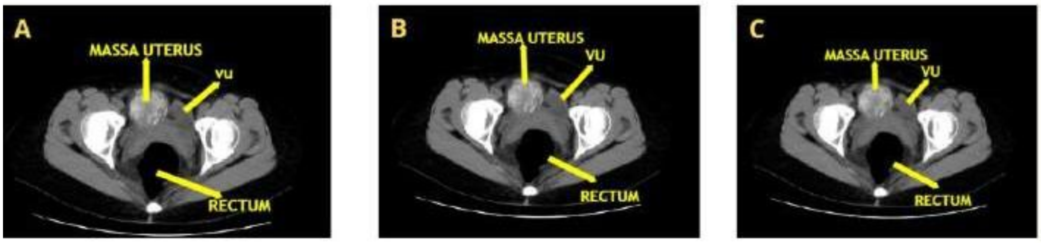

Figure 10. Anatomical Information of Uterine Mass, Urinary Vesicles, and Rectum using (A) 60% ASiR Variation; (B) 70% ASiR Variation; and (C) 80% ASiR Variation

DISCUSSION

The 67% variation in ASiR values had the highest average rating for each anatomy evaluated. Based on the average rating of each anatomy, the absolute SNR values for the arterial masses of the liver, portal vein, hepa, spleen, kidneys, uterus, and stomach showed a consistent decrease. It states that using 60% and 70% of ASiR-V can merge noise and improve signal quality. Previous studies reported that a 70% variation in ASiR-V significantly increased SNR when assessing the abdominal parenchyma (Guangyi et al., 2024). The same is true of the findings (Kwon, 2015), which stated that the 70% variation of ASiR-V showed low noise and a high degree of spatial correlation. So that the variation in the ASiR-V value of 70% has a high SNR value, which means that the ratio between signals is higher than the noise, so that the picture can be seen optimally and can improve the accuracy of the diagnosis. Iterative reconstruction can theoretically reduce noise without sacrificing spatial resolution compared to filtered back projection (Seeram, 2019).

70% ASiR-V yields more optimal, consistent CNR values than 60% or 80% ASiR-V. Based on studies by Prezzi et al. (2017), variations in ASiR-V values above 60% can reduce noise but also reduce the sharpness and visibility of small structures, thereby reducing diagnostic accuracy. In this study, ASiR-V at 80% had the highest value, enabling interpretation of small structures and optimal sharpness. The most affected images are the lungs and the left lobe of the liver. The increase in CNR values in the lungs is due to very strong noise cancellation and large differences in HU values. Meanwhile, in the left lobe of the liver, this occurs due to strong noise cancellation, resulting in a smoother contrast gradient and more homogeneous tissue contours (Xue et al., 2023).

The results of the test between CT Accuracy of Number HU and the variation in the ASiR-V value showed the highest average rating: Standard Deviation HU with an ASiR-V of 60%. This means that the lower the variation in the ASiR-V used, the less ability to reduce noise in the image. Based on the data above, the previous study found that the greater the variation in ASiR-V used, the lower the noise (standard deviation), which also affects the CNR (Prezzi et al., 2017). The same is true of the findings of Guangyi et al. (2024), who found that SD HU will be significantly reduced as the value of the ASiR-V used increases. The recently used iterative reconstruction algorithm can reduce noise compared to the filter back projection (FBP) method with the same checks and parameters (Cau Shayne, 2023).

The analysis reveals that the 60% ASiR-V variation achieves the highest average rating, showcasing its ability to clearly display anatomical details of organs such as the lungs, liver, gallbladder, pancreas, spleen, stomach, kidneys, abdominal aorta, psoas muscle, subcutaneous fat, urinary bladder, rectum, and intra-abdominal masses. This variation produces high-quality, detailed, sharp, and accurate images, enhancing diagnostic accuracy more effectively than a radiologist alone.

Different ASiR-V values can optimize imagery for tissues with high noise, but setting the ASiR-V at its maximum can lead to blurred organ boundaries due to excessive smoothing or noise, resulting in image artifacts (Hara et al., 2009). The study found that the 60% ASiR-V setting yields the best anatomical clarity, effectively reducing noise without oversmoothing, thereby preserving essential anatomical details (Saifudin, 2017).

From the results of the analysis of the average rating, it can be seen that the 60% ASiR-V variation has the highest average which shows that the ASiR-V variation has the best ability to demonstrate and clarify anatomical information of the lungs, hepar, gallbladder, pancreas, spleen, gaster, renal, abdominal aorta, psoas muscle, subcutaneous fat, urinary vesicles, rectum, and intra-abdominal masses. With the highest average, the 60% ASiR-V variation produces images with optimal quality and visualizes more detailed, sharper, and more accurate anatomy, helping the diagnostic process more than a radiologist. In this study, the best anatomical information was obtained at an ASiR-V variation of 60% because the resulting image had clear spatial resolution. It can be concluded that noise can be reduced without being excessively so that no oversmoothing causes anatomical details to be reduced or disappear (Saifudin, 2017).

CONCLUSION

This study reports that ASiR-V values of 60%, 70%, and 80% differ significantly in image quality and image information on CT scans of Intra-Abdominal Tumors. In the case of intra-abdominal tumors, 60% ASiR-V is recommended because the abdomen is mostly composed of soft tissues. Hence, it requires high anatomical detail and sharp boundaries between organs to improve diagnostic accuracy, whereas the variation in ASiR-V values of 70% and 80% results in oversmooth images, thereby reducing picture detail. Based on the results of the above study, the authors' findings can serve as a reference for clinical practice and for subsequent researchers in developing efficient, scientifically based CT scan protocols, and suggest that future researchers should examine the relationship between the use of variations in ASiR-V values and radiation doses, and use more samples.

These findings can serve as a reference for clinical practice and for subsequent researchers in developing efficient, scientifically based CT scan protocols. This study has several limitations; the first is the relatively small sample size. The focus of this study was the evaluation of abdominal CT scan images based on HU, SNR, CNR, and radiologists' subjective assessments. However, it did not evaluate the radiation dose received by the patient. Third, variations in patient characteristics, such as differences in the patient's body mass index. Moreover, lastly, it is only one type of vendor.

AUTHOR'S DECLARATION

Authors' contributions and responsibilities

DPA: Writing original draft, visualization, funding acquisition, conceptualization; **SS:** Writing original draft (supporting); **FS:** Supervision (lead), validation (equal), visualization (equal), review and editing; **HSU:** Writing original draft, formal analysis, conceptualization; **LF:** Writing original draft (supporting).

Availability of data and materials

All data are available from the authors.

Competing interests

The authors declare no competing interests.

ACKNOWLEDGEMENT

The author would like to express his gratitude to all parties who have provided support, assistance, and meaningful contributions in the implementation of this research and in the preparation of this article. Special thanks are extended to the institution where the research is located for providing the necessary facilities and support. The author gratefully acknowledges all individuals and organizations that offered crucial support, assistance, and valuable contributions during the execution of this research and the preparation of this article. Special recognition is due to the institution where the research took place for consistently providing essential facilities and support.

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