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Original Research Paper

Optimization of image quality of non-contrast urography CT tracking with the selection of the right iDose[4] level iterative reconstruction technique

Muhamad Faik
Department of Radiology, Universitas 'Aisyiyah Yogyakarta, Mlangi Nogotirto, Jl. Siliwangi No.63, Nogotirto, Kec. Gamping, Kabupaten Sleman, Daerah Istimewa Yogyakarta, 55592, Indonesia
faik.muhamad@unisayogya.ac.id

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Abstract
Optimal urinary tract image and able to identify differences in urinary tract image information on urography CT is urography CT tracking image with a thin slice thickness parameter of 1 mm (Sulaksono et al., 2016). However, the thinner the slice thickness will produce high noise that can affect the diagnosis. The FBP algorithm, the standard algorithm for image reconstruction on CT scans, produces streak artifacts and significantly increases image noise when the radiation dose is reduced tremendously (Willemink, de Jong et al., 2013; Willemink, Leiner et al., 2013). Iterative reconstruction iDose[4] is a fourth-generation image reconstruction technique that can significantly improve image quality, noise reduction, and radiation dose reduction. This study aims to determine the difference in noise values and diagnostic information of non-contrast urography CT tracking images with variations in FBP and iDose four reconstruction techniques. This type of research is experimental research. Data collection began in May 2022 to June 2022 at the Radiology Installation of RSUD Salatiga City. The results showed that selecting iDose[4] level 6 iterative reconstruction techniques produced the best image quality and diagnostic information on coronal tracking images of urinary tract CT non-contrast urography. Therefore, the iDose[4] level 6 iterative reconstruction technique should be used as a standard protocol for conducting non-contrast urography CT examinations.

Keywords: CT urography non-contrast; Filtered Back Projection (FBP); iDose[4]; image quality

1. Introduction

Over the past few decades, a conventional radiological examination of the urinary tract called Intravenous Urography (IVU) has become a mainstay in diagnosing urolithiasis and obstruction of the urinary tract. Along with the development of imaging modalities, most of these IVU examinations are replaced by non-contrast CT Scans (Low &; Teh, 2015). In diagnosing urolithiasis on non-contrast urography CT, it is necessary to track the kidneys, ureters, and urinary vesicles to distinguish urolithiasis from appendicoliths, phleboliths, or calcifications in the iliac arteries (Faik et al., 2018). The non-contrast abdominal CT Scan tracking results can produce optimal urinary tract images (Sulaksono et al., 2016).

The ureter is a small tubular organ that drains urine from the renal pielum into the urinary vesicle with a length of approximately 20-30 cm and a normal diameter of less than 3 mm (Purnomo, 2015). With a small ureter diameter (<3 mm), the slice thickness must be thin to optimize the resulting tracking image. The tracking results on a non-contrast abdominal CT scan can produce optimal urinary tract images and identify differences in urinary tract image information after reconstruction tracking with thin slice thickness parameters of 1 mm (Sulaksono et al., 2016).

Slice thickness is the thickness of the slice or piece of the examined object. The value can be selected between 1 mm–10 mm according to clinical needs. A thinner slice thickness will produce a high spatial resolution, but a thinner slice thickness will also produce high noise. Noise is a fluctuation in the CT Number value in homogeneous tissue or material where a high noise value will interfere with the CT Scan image's contrast resolution, eventually affecting the diagnosis results (Bushong, 2013). Therefore, tracking images on non-contrast abdominal CT scans made with a thin slice thickness of 1 mm will tend to produce high noise.

For many years, the Filtered Back Projection (FBP) algorithm has been the standard algorithm for image reconstruction on CT scans. Still, it allows the generation of streak artifacts and significant increases in image noise when the radiation dose is reduced tremendously. With technological advances and increased computing capacity in workstations, iterative reconstruction (IR) algorithms have emerged as a potential alternative (Qiu &; Seeram, 2018). Iterative reconstruction iDose^4 is a fourth-generation image reconstruction technique that can significantly improve image quality and reduce radiation doses. Using iDose^4 on Philips CT has provided additional clinical benefits that can adjust spatial resolution and dose reduction benefits to specific clinical indications (Arapakis et al., 2014; Willemink, de Jong et al., 2013; Willemink, Leiner, et al., 2013).

Based on researchers' observations at the Radiology Installation of RSUD Salatiga, the reconstruction technique on non-contrast urography CT examinations uses a standard protocol from the vendor, namely the iDose^4 level 3 iterative reconstruction technique. The iDose^4 iterative reconstruction technique provides a choice of variations ranging from level 1 to level 6. According to Hou et al. (2013), increasing the level of iDose^4 will result in a linear decrease in noise in the image, so using iterative reconstruction iDose^4 level 6 will produce the best image quality with the smallest noise. This study aimed to determine the selection of appropriate reconstruction techniques that produce the lowest noise image quality and the best diagnostic information on coronal tracking images of the urinary tract, CT, and non-contrast urography.

2. Research Methods

This research is an experimental study. The study was conducted by providing seven treatments on urinary tract coronal tracking images on non-contrast urography CT, namely using Filtered Back Projection (FBP) reconstruction techniques, iterative reconstruction iDose^4 level 1, iDose^4 level 2, iDose^4 level 3, iDose^4 level 4, iDose^4 level 5, and iDose^4 level 6. Seven treatments were administered to see the presence or absence of differences in noise values and diagnostic information on the resulting urinary tract coronal tracking image and to see which treatment was best. The independent variable in this study was the reconstruction technique. The dependent variable in this study was image quality consisting of noise and diagnostic information on coronal tracking images of the urinary tract on non-contrast urography CT. The controlled variables in this study were parameters kV, mAs, FOV, matrix, increment, filter, window width, and window level.

In this study, the definition of reconstruction techniques is non-contrast urography CT Scan images using seven variations of reconstruction techniques, namely Filtered Back Projection (FBP), iterative reconstruction iDose^4 level 1, iDose^4 level 2, iDose^4 level 3, iDose^4 level 4, iDose^4 level 5, and iDose ^{4} level 6. Noise is a standard deviation or fluctuation in the CT number value of the coronal image tracking of the urinary tract on non-contrast urography CT in the kidney, ureter, and urinary vesicles. Diagnostic information is used to diagnose urinary tract abnormalities obtained from coronal tracking images of the urinary tract on non-contrast urography CT that can show anatomy and abnormalities in the kidneys, ureters, and urinary vesicles. The tools and materials used in this study were Philips CT Scan aircraft type Ingenuity 128, Region of Interest (ROI) software, checklist, and coronal tracking image of the urinary tract on non-contrast urography CT using a variety of settings of Filtered Back Projection (FBP) reconstruction techniques, iterative reconstruction iDose^4 level 1, iDose^4 level 2, iDose^4 level 3, iDose^4 level 4, iDose^4 level 5, and iDose^4 level 6.

The collection of research data on differences in diagnostic information on non-contrasting urography CT tracking images with variations in reconstruction techniques was from January 2022 to June 2022 at the Radiology Installation of RSUD Salatiga. The subjects who played a role in the completeness of this study were urinary tract coronal tracking images on non-contrast urography CT and respondents in this study were three radiographers with competence to perform urography CT Scans and three radiologists with competence to conduct expertise or assessment of urography CT Scan image results. The population in this study was all non-contrast urography CT examinations at the Radiology Installation of RSUD Salatiga. The sample in this study was a non-contrast urography CT examination taken by accidental sampling technique. In this study, the author obtained noise value data from the measurement results of 3 radiographers on noise values or standard deviation of coronal image tracking urinary tract on non-contrast urography CT in the kidney, ureter, and urinary vesicles using Region of Interest (ROI) software.

Diagnostic information was obtained by providing a checklist to 3 respondents, namely radiologists (radiologists), to provide an assessment of each non-contrasting urography CT tracking coronal image with different reconstruction techniques in the form of numerical data so that statistical analysis could be carried out checklist containing one sheet of film containing seven images coronal tracking of the urinary tract on non-contrast urography CT with different reconstruction techniques namely Filtered Back Projection (FBP), iterative reconstruction iDose^4 level 1, iDose^4 level 2, iDose^4 level 3, iDose^4 level ^{4}, iDose^4 level 5, and iDose^4 level 6. At the same time, the patient's identity and parameters are omitted. The radiologist will observe each image as objectively as possible by giving a check mark (√) in the available column following the standard values that have been determined on the checklist, namely: value 1 for uninformative/unclear opinions, value 2 for informative/clear opinions, value 3 for opinions. Data from the results of noise value measurements and checklists of diagnostic information coronal image tracking CT urography non-contrast were then processed and analyzed the data. Data analysis was carried out with non-parametric statistical tests, Friedman test. A statistical analysis assigns the value a confidence level (significance level). $\alpha = 0{,}05$

3. Results and Research

3.1. Differences in Noise Values of Coronal Tracking Urinary Tract Images on Non-Contrast Urography CT with Variations in Reconstruction Techniques

From the coronal image sample tracking the urinary tract on non-contrast urography CT with seven variations of reconstruction techniques taken then, the noise value was measured by three respondents (radiographers) to obtain noise values or standard deviations in the kidney, ureter, and urinary vesicles using Region of Interest (ROI) software.

Table 1. Average results of noise value measurement by three radiographers against non-contrast urography CT tracking images with seven variations of reconstruction techniques

Radiographer	Noise value measurement						
	FBP	iDose^4 level 1	iDose^4 level 2	iDose^4 level 3	iDose^4 level 4	iDose^4 level 5	iDose^4 level 6
1	19.20	16.27	14.93	12.90	10.63	9.23	6.03
2	16.50	13.90	14.70	10.50	12.20	9.03	8.33
3	16.87	14.97	13.57	12.50	9.10	10.97	8.97
Jumlah	**52.57**	**45.13**	**43.20**	**35.90**	**31.93**	**29.23**	**23.33**

Table 2. The average value of image noise value assessment tracking CT urography non-contrast with seven variations of reconstruction techniques

No	Sample Group	Number of Samples	Value	
			Average	Standard Deviation
1	FBP	3	17.522	1.464
2	iDose^4 level 1	3	15.044	1.187
3	iDose^4 level 2	3	14.400	0.728
4	iDose^4 level 3	3	11.967	1.286
5	iDose^4 level 4	3	10.644	1.550
6	iDose^4 level 5	3	9.744	1.067
7	iDose^4 level 6	3	7.778	1.546

From the average table of diagnostic information assessment of non-contrast urography CT tracking images with the seven variations of reconstruction techniques above, it can be seen that non-contrast urography CT tracking images with iDose^4 level 6 iterative reconstruction have the lowest average noise value of 7.778 with a standard deviation of 1.546. Non-contrast urography CT tracking images with Filtered Back Projection (FBP) have the highest average noise value of 17.522 with a standard deviation of 1.464. Non-contrast urography CT tracking images with iDose^4 level 1 iterative reconstruction have an average noise value of 15.044 with a standard deviation of 1.187. Non-contrast urography CT tracking images with iDose^4 level 2 iterative reconstruction have an average noise value of 14.400 with a standard deviation of 0.728. Non-contrast urography CT tracking images with iDose^4 level 3 iterative reconstruction have an average noise value of 11.967 with a standard deviation of 1.286. Non-contrast urography CT tracking images with iDose^4 level 4 iterative reconstruction have an average noise value of 10.644 with a standard deviation of 1.550. Non-contrast urography CT tracking images with iDose^4 level 5 iterative reconstruction have an average noise value of 9.744 with a standard deviation of 1.067.

The results of the Friedman test statistical test on the comparison of noise value measurement of non-contrast urography CT tracking images with seven variations of reconstruction techniques can be seen in the table below:

Table 3. Friedman test statistical test results on the measurement of image noise value tracking CT urography non-contrast with seven variations of reconstruction techniques

Independent Variable	Dependent Variables	P value	Explanation
Reconstruction Techniques	Coronal image noise tracking urinary tract on non-contrast urography CT	0.009	There are differences in coronal image noise tracking urinary tract on non-contrast urography CT

Based on the Friedman test analysis results, if the p-value> 0.05, then Ho is accepted, and if the p-value < 0.05, then Ho is rejected. It can be seen that in the column asymp.sign/asymptotic significance, the p-value is 0.009, or the probability is below 0.05 (0.009 < 0.05). The conclusion Ho is rejected and Ha is accepted, which means that there is a significant difference in the noise value of the urinary tract tracking coronal image on non-contrast urography CT with seven variations of reconstruction techniques, namely Filtered Back Projection (FBP), iterative reconstruction iDose^4 level 1, iDose^4 level 2, iDose^4 level 3, iDose^4 level 4, iDose^4 level 5, and iDose^4 level 6 with p-value = 0.009 at a significance level of 95%.

From the results of the Friedman statistical test, the average noise ranking of each reconstruction technique is also obtained in the following table:

Table 4. Average ranking of noise values of each reconstruction technique

Image	Mean Rank
A FBP	7.00
B iDose^4 level 1	5.67
C iDose^4 level 2	5.33
D iDose^4 level 3	3.67
E iDose^4 level 4	3.00
F iDose^4 level 5	2.33
G iDose^4 level 6	1.00

From the table above, it can be seen that the average rank of the coronal image noise value tracking urinary tract on non-contrast urography CT with FBP is 7.00, iterative reconstruction iDose^4 level 1 is 5.67, level 2 is 5.33, level 3 is 3.67, level ^{4} is 3.00, level 5 is 2.33, and level 6 is 1.00. This shows that the average ranking order of the lowest noise value is iterative reconstruction iDose^4 level 6, followed by level 5, level ^{4}, level 3, level 2, level 1, and FBP reconstruction techniques. From the data from the study above, it shows that there is a significant difference in the noise value of urinary tract coronal tracking images on non-contrast urography CT with variations in FBP reconstruction techniques, iterative reconstruction iDose^4 levels, namely level 1, level 2, level 3, level 4, level 5 and level 6, and of the seven variations of reconstruction techniques, urinary tract coronal tracking images on non-contrast urography CT with iDose^4 iDose reconstruction variations the highest level, level 6, has the lowest noise.

This can be seen in table 1, which shows the difference in the average noise value of urinary tract coronal tracking images on non-contrast urography CT with seven variations of reconstruction techniques, and table 2, which shows the average noise ranking of each variation of reconstruction techniques. Urinary tract tracking coronal imagery on non-contrast urography CT with iDose^4 level 6 iterative reconstruction variation had the lowest average noise value of 7.778 and an average rating of 1.00. Non-contrast urography CT tracking images with Filtered Back Projection (FBP) have the highest average noise value of 17.522 and an average ranking of 7.00. Non-contrast urography CT tracking images with iDose^4 level 1 iterative reconstruction have an average noise value of 15.044 and an average rating of 5.67. Non-contrast urography CT tracking images with iDose^4 level 2 iterative reconstruction have an average noise value of 14.400 and an average rating of 5.33. Non-contrast urography CT tracking images with iDose^4 level 3 iterative reconstruction have an average noise value of 11.967 and an average rating of 3.67. Non-contrast urography CT tracking images with iDose^4 level ^{4} iterative reconstruction have an average noise value of 10.644 and an average rating of 3.00. Non-contrast urography CT tracking images with iDose^4 level 5 iterative reconstruction have an average noise value of 9.744 and an average rating of 2.33. The data was also tested through statistical tests with p-value = 0.009 ($p < 0.05$).

The difference in coronal image noise tracking urinary tract in non-contrast urography CT is due to the influence of choosing different reconstruction techniques. Different reconstruction techniques will affect noise, an important CT scan image quality component. For many years, the Filtered Back Projection (FBP) algorithm has been the standard algorithm for image reconstruction on CT scans. Still, it allows the generation of streak artifacts and significant increases in image noise when the radiation dose is reduced tremendously. With technological advances and increased computing capacity in workstations, iterative reconstruction (IR) algorithms have emerged as a potential alternative (Qiu &; Seeram, 2018). iDose^4 is a fourth-generation image reconstruction technique that can provide improved image quality and significant reductions in radiation dose. Using iDose^4 on Philips CT has provided additional clinical benefits that can adjust spatial resolution and dose reduction benefits to specific clinical indications (Arapakis et al., 2014). Therefore, according to the results of this study that the reconstruction technique with FBP will produce urography CT images with higher noise compared to iDose^4 iterative reconstruction.

With iDose^4, the measurement of the highest noise value will be given a low weight in an iterative process so that noise contributes very little to the final image. Therefore, IR techniques treat noise correctly at very low signal levels and consequently can reduce noise and artifacts present in the reconstructed image. This results in an overall improvement in image quality at a given dose. With IR techniques, noise can be controlled for high-resolution spatial reconstruction, thus providing low-contrast and high-resolution image quality in the same image (Willemink, de Jong et al., 2013; Willemink, Leiner et al., 2013). According to Xu et al. (2019), the use of iterative reconstruction such as Adaptive Statistical IR (ASIR), Model-Based IR (MBIR, under the trade name "VEO", General Electric Company), and iDose^4 (Philips Medical Company) on CT Scan examination with low doses can reduce image noise and improve image quality.

According to Hou et al. (2013), the iDose^4 reconstruction algorithm will produce lower image noise at the same radiation dose than the FBP reconstruction algorithm. With an increase in iDose^4 levels, image noise will decrease linearly. Therefore, using iDose^4 iterative reconstruction will reduce noise compared to FBP reconstruction techniques. The higher the level of iDose^4 iterative reconstruction will decrease noise so that the ability of coronal tracking imagery of the urinary tract in non-contrast urography CT produced to distinguish small objects with different densities on the same background will also increase.

According to researchers, with the ability of iDose^4 to reduce noise significantly, to further minimize noise caused by setting a thin slice thickness on non-contrast urography CT tracking images, which is 1 mm, can be done by raising the level of iDose^4 iterative reconstruction from level 3 to level 6. According to researchers, with the ability of iDose^4 to reduce noise significantly, to further minimize the risk of radiation hazards received by patients, the radiation dose of standard CT urography examination commonly used can be reduced. The increase in noise resulting from this reduction in radiation dose can be overcome by raising the level of iDose^4 iterative reconstruction so that the resulting urography CT image noise will be the same as urography CT using the standard radiation dose commonly used. This is reinforced by the results of research conducted by Xu et al. (2019), which states that the use of iterative reconstruction such as Adaptive Statistical IR (ASIR), Model-Based IR (MBIR, under the trade name "VEO", General Electric Company), and iDose^4 (Philips Medical Company) on CT Scan examination with low doses can reduce noise image and improve image quality.

3.2. Differences in diagnostic information of urinary tract tracking coronal images on non-contrast urography CT with variations in reconstruction techniques

From the sample of urinary tract coronal tracking images on non-contrast urography CT with seven variations of reconstruction techniques taken, diagnostic information assessment was then carried out by respondents (radiologists) to obtain an assessment of urinary tract diagnostic information using an instrument in the form of a checklist. The checklist consists of 3 question items with a range of values 1-3, so each image will get a minimum number of values of 3 and a maximum of 9.

Table 5. Average results of diagnostic information assessment of 3 radiologists against non-contrast urography CT tracking images with seven variations of reconstruction techniques

Radiologist	Assessment of diagnostic information						
	FBP	$iDose^4$ level 1	$iDose^4$ level 2	$iDose^4$ level 3	$iDose^4$ level 4	$iDose^4$ level 5	$iDose^4$ level 6
1	1	1.667	2	2.333	3	3	3
2	1	1	1.667	2	2	2.333	2.667
3	1.333	2	2	3	3	3	3
Jumlah	**3.333**	**4.667**	**5.667**	**7.333**	**8**	**8.333**	**8.667**

From the table above, it can be seen the results of the assessment by respondents of 3 radiologists on diagnostic information of non-contrast urography CT tracking images with seven variations of reconstruction techniques.

Table 6. The average value of diagnostic information assessment of non-contrast urography CT tracking with seven variations of reconstruction techniques

No	Sample Group	Number of Samples	Value	
			Average	Standard Deviation
1	FBP	3	1.111	0.192
2	$iDose^4$ level 1	3	1.556	0.509
3	$iDose^4$ level 2	3	1.889	0.192
4	$iDose^4$ level 3	3	2.444	0.509
5	$iDose^4$ level 4	3	2.667	0.577
6	$iDose^4$ level 5	3	2.778	0.385
7	$iDose^4$ level 6	3	2.889	0.192

From the average assessment table of diagnostic information of non-contrast urography CT tracking images with the seven variations of reconstruction techniques above, it can be seen that non-contrast urography CT tracking images with iterative reconstruction $iDose^4$ level 6 have the highest average diagnostic information value of 2.889 with a standard deviation of 0.192. Non-contrast urography CT tracking images with $iDose^4$ level 1 iterative reconstruction had a diagnostic information mean value of 1.556 with a standard deviation of 0.509. Non-contrast urography CT tracking images with $iDose^4$ level 2 iterative reconstruction had a diagnostic information mean value of 1.889 with a standard deviation of 0.192. Non-contrast urography CT tracking images with $iDose^4$ level 3 iterative reconstruction had a diagnostic information mean value of 2.444 with a standard deviation of 0.509. Non-contrast urography CT tracking images with $iDose^4$ level 4 iterative reconstruction had a diagnostic information mean value of 2.667 with a standard deviation of 0.577. Non-contrast urography CT tracking images with $iDose^4$ level 5 iterative reconstruction had a diagnostic information mean value of 2.778 with a standard deviation of 0.385. Non-contrast urography CT tracking images with Filtered Back Projection (FBP) have the smallest average diagnostic information value of 1,111 with a standard deviation of 0.192. Non-contrast urography CT tracking images with seven variations of reconstruction techniques can be seen below:

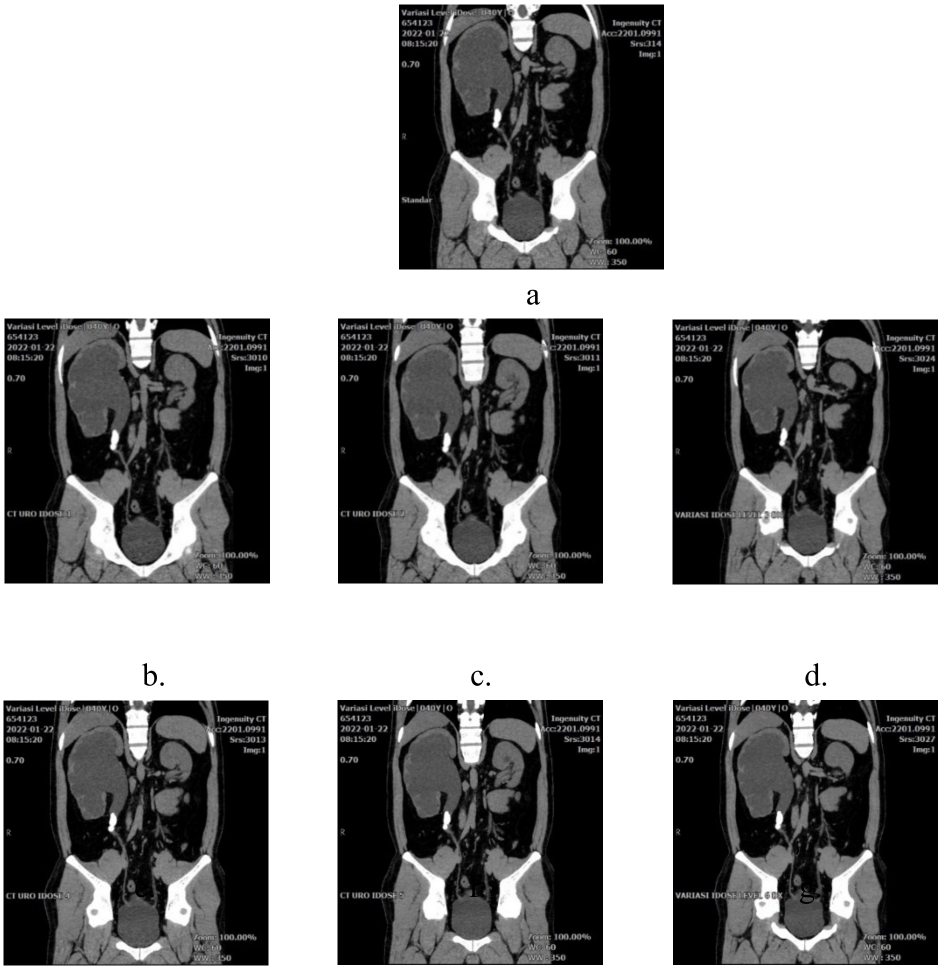

Figure 1. Non-contrasting urography CT tracking imagery with variations in iterative reconstruction
Information:

a. Non-contrast urography CT tracking image with Filtered Back Projection (FBP)
b. Non-contrasting urography CT tracking image with iDose^4 level 1 iterative reconstruction
c. Non-contrast urography CT tracking image with iDose^4 level 2 iterative reconstruction
d. Non-contrasting urography CT tracking image with iDose^4 level 3 iterative reconstruction
e. Non-contrasting urography CT tracking image with iDose^4 level 4 iterative reconstruction
f. Non-contrasting urography CT tracking image with iDose^4 level 5 iterative reconstruction
g. Non-contrasting urography CT tracking image with iDose^4 level 6 iterative reconstruction

After the data is obtained, to determine whether the results of the assessment of diagnostic information of non-contrast urography CT tracking images with seven variations of reconstruction techniques have significant differences or not, a statistical Friedman test is carried out.

The results of the Friedman test statistical test on the comparison of diagnostic information assessment of non-contrast urography CT tracking images with seven variations of reconstruction techniques can be seen in the table below:

Table 7. Friedman test results on the assessment of diagnostic information of non-contrast urography CT tracking images with seven variations of reconstruction techniques

Independent Variable	Dependent Variables	p-value	Information
Reconstruction techniques	Diagnostic information of urinary tract coronal tracking image on non-contrast urography CT	0.010	There are differences in diagnostic information of urinary tract coronal tracking images on non-contrast urography CT

Based on the Friedman test analysis results, if the p-value> 0.05, then Ho is accepted, and if the p-value < 0.05, then Ho is rejected. It can be seen that in the column asymp.sign/asymptotic significance, the p-value is 0.010, or the probability is below 0.05 (0.010 < 0.05). The conclusion Ho is rejected and Ha is accepted, which means that there is a significant difference in the diagnostic information of coronal image tracking urinary tract on non-contrast urography CT with seven variations of reconstruction techniques, namely Filtered Back Projection (FBP), iterative reconstruction iDose^4 level 1, iterative reconstruction iDose^4 level 2, iterative reconstruction iDose^4 level 3, iterative reconstruction iDose^4 level 4, iterative reconstruction iDose^4 level 5, and iterative reconstruction iDose^4 level 6 with p-value = 0.010 at a significance level of 95%.

From the results of the Friedman test statistical tests, the average results of the ranking of diagnostic information for each reconstruction technique are obtained in the following table:

Table 8. Average ranking of diagnostic information of each reconstruction technique

Images	Mean Rank
A FBP	1.17
B iDose^4 level 1	2.00
C iDose^4 level 2	2.83
D iDose^4 level 3	4.67
E iDose^4 level 4	5.33
F iDose^4 level 5	5.83
G iDose^4 level 6	6.17

From the table above, it can be seen that the average rank of diagnostic information of urinary tract coronal tracking image on non-contrast urography CT with FBP is 1.17, iterative reconstruction iDose^4 level 1 is 2.00, level 2 is 2.83, level 3 is 4.67, level ^{4} is 5.33, level 5 is 5.83, and Level 6 is 6.17. This shows that the average order of ranking the highest diagnostic information is iterative reconstruction iDose^4 level 6, followed by level 5, level ^{4}, level 3, level 2, level 1, and FBP. The data of the results of the study above shows that there are significant differences in the diagnostic information of urinary tract coronal tracking images on non-contrast urography CT with variations in reconstruction techniques, namely FBP, iterative reconstruction iDose^4 level 1, level 2, level 3, level 4, level 5 and level 6. Of the seven variations of reconstruction techniques, the coronal tracking image of the urinary tract on non-contrast urography CT with the highest level of iDose^4 iterative reconstruction variation, namely level 6, has the best/clear/informative diagnostic information.

This can be seen in table 6, which shows the difference in the average value of diagnostic information of urinary tract coronal tracking image on non-contrast urography CT with seven variations of reconstruction techniques, and table 8, which shows the average ranking of diagnostic information from each variation of reconstructive technique. Urinary tract tracking coronal image on non-contrast urography CT with iDose^4 level 6 iterative reconstruction variation had the highest diagnostic information mean value of 2.889 and average rank of 6.17, urinary tract coronal tracking image on non-contrast urography CT with iterative reconstruction iDose[4] level variation 1 has an average diagnostic information value of 1.556 and an average rank of 2.00, urinary tract coronal tracking image on non-contrast urography CT with iterative reconstruction variation iDose[4] level 2 has an average diagnostic information value of 1.889 and an average rank of 2.83, urinary tract coronal tracking image on non-contrast urography CT with variation iDose[4] level 3 iterative reconstruction has a mean diagnostic information value of 2.444 and an average rating of 4.67, urinary tract coronal tracking images on non-contrast urography CT with iterative reconstruction variation iDose[4] level 4 have an average diagnostic information value of 2.667 and an average rank of 5.33, coronal tracking images urinary tract on non-contrast urography CT with iDose[4] level 5 iterative reconstruction variation had a mean diagnostic information value of 2.778 and an average rank of 5.83, and urinary tract coronal tracking images on non-contrast urography CT with FBP had the lowest average diagnostic information value of 1.111 and an average rank of 1.17. The data was also tested through statistical tests with p-value = 0.010 ($p < 0.05$).

The difference in diagnostic information of urinary tract coronal tracking images on non-contrast urography CT is due to the influence of the selection of different reconstruction techniques. Different reconstruction techniques will affect noise, an important CT scan image quality component. In diagnosing urinary tract abnormalities on non-contrast urography CT, it is necessary to track the kidneys, ureters, and urinary vesicles to distinguish urolithiasis from appendicoliths, phleboliths, or calcifications in the iliac arteries (Faik et al., 2018). The non-contrast abdominal CT Scan tracking results can produce optimal urinary tract images (Sulaksono et al., 2016). The ureter is a small tubular organ that functions to drain urine from the renal pielum into the urinary vesicle with a length of approximately 20-30 cm and a normal diameter of less than 3 mm (Purnomo, 2015). With a small ureter diameter (<3 mm), in order for the resulting tracking image to be optimal and able to identify differences in urinary tract image information, slice thickness of non-contrast urography CT tracking images must be made thin, namely 1 mm (Sulaksono et al., 2016).

A thinner slice will produce a high spatial resolution, but a thinner slice thickness will also produce high noise (Bushberg et al., 2014). Noise is a fluctuation in the CT Number value in a homogeneous network or material where a high noise value will interfere with the contrast resolution of the CT Scan image, eventually affecting the results of diagnosis or diagnostic information (Bushong, 2013). For many years, the Filtered Back Projection (FBP) algorithm has been the standard algorithm for image reconstruction on CT scans. Still, it allows the generation of streak artifacts and significant increases in image noise when the radiation dose is reduced tremendously. With technological advances and increased computing capacity in workstations, iterative reconstruction (IR) algorithms have emerged as a potential alternative (Qiu &; Seeram, 2018). iDose[4] is a 4th generation image reconstruction technique that can significantly improve image quality and reduce radiation doses. Using iDose[4] on Philips CT has provided additional clinical benefits that can adjust spatial resolution and dose reduction benefits to specific clinical indications (Arapakis et al., 2014; Willemink, de Jong et al., 2013; Willemink, Leiner, et al., 2013).

With iDose[4], the measurement of the highest noise value will be given a low weight in an iterative process so that noise contributes very little to the final image. Therefore, IR techniques treat noise correctly at very low signal levels and consequently can reduce noise and artifacts present in the reconstructed image. This results in an overall improvement in image quality at a given dose. With IR techniques, noise can be controlled for high-resolution spatial reconstruction, thus providing low-contrast and high-resolution image quality in the same image (Arapakis et al., 2014). The iDose[4] reconstruction technique can also prevent artifacts and limit mottle quantum noise, providing diagnostically equivalent images to routine dose acquisition. High image quality includes low noise and artifacts, and high-resolution contrast and spatial resolution can improve diagnostic information for urography CT images.

According to Hou et al. (2013), the $iDose^4$ reconstruction algorithm will produce lower image noise at the same radiation dose than the FBP reconstruction algorithm. With an increase in $iDose^4$ levels, image noise will decrease linearly. Therefore, using $iDose^4$ iterative reconstruction will reduce noise compared to FBP reconstruction techniques. The higher the level of iterative reconstruction $iDose^4$ will result in noise decreasing so that spatial resolution or coronal image tracking capabilities The urinary tract in non-contrast urography CT produced to be able to distinguish small objects with different densities on the same background will also increase so that the diagnostic information produced is also high and accurate.

According to researchers, with the ability of $iDose^4$ to reduce noise significantly, to further minimize noise caused by setting a thin slice thickness on non-contrast urography CT tracking images, which is 1 mm, can be done by raising the level of $iDose^4$ iterative reconstruction from level 3 to level 6. By raising the level of iterative reconstruction $iDose^4$ from level 3 to level 6, the quality of the resulting non-contrast urography CT tracking image is better because the noise produced is lower, so it can improve diagnostic information on the urinary tract more clearly and accurately.

4. Conclusion

1. The selection of $iDose^4$ level 6 iterative reconstruction techniques can produce the best image quality and diagnostic information on coronal tracking images of the urinary tract, CT, and non-contrast urography.
2. There is a significant difference in the noise value of non-contrast urography CT tracking images with seven variations of reconstruction techniques, namely FBP, iterative reconstruction $iDose^4$ level 1, level 2, level 3, level ^{4}, level 5, and level 6, with p-value = 0.009 ($p < 0.05$).
3. There is a significant difference in diagnostic information of non-contrasting urography CT tracking images with seven variations of reconstruction techniques, namely FBP, iterative reconstruction $iDose^4$ level 1, level 2, level 3, level ^{4}, level 5, and level 6, with p-value = 0.010 ($p < 0.05$).
4. Among the seven variations of reconstruction techniques, namely FBP, iterative reconstruction $iDose^4$ level 1, level 2, level 3, level 4, level 5, and level 6, non-contrast urography CT tracking images with $iDose^4$ level 6 iterative reconstruction has the lowest noise value with an average rating of 1.00 and the best/informative/clear diagnostic information value with the highest average rating value of 6.17.

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