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Original Research Paper

The Effect of Using Black Tea as an Alternative Diuretic on Multislice Computed Tomography (MSCT) Urography Examination

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Abstract
The MSCT urography examination requires patient preparation, such as fasting and drinking water.In addition,some hospitals use water,furosemide to accelerate the increase in urine volume.However,Furosemide is a chemical diuretic that is feared to increase the workload of the kidneys. So a natural alternative is needed, namely black tea.This study aims to determine the effect of black tea as an alternative diuretic on the urography MSCT examination. This is quasi-experimental research conducted at RSUD by Dr. Soehadi Prijonegoro Sragen,Central Java. Respondents in this study consisted of 18 outpatients with an MSCT urography examination. These respondents were divided into three groups, namely the group of mineral water, furosemide,and black tea, and three radiology doctors. The scanning process uses MSCT 128 Slice and then tracks MSCT urography with the Curved Multiplanar Reconstruction (MPR) application.Data obtained from observations,questionnaires,and interviews with radiologists was then processed and analyzed using quantitative methods.Normal distributed data was analyzed using the ANOVA test. The results showed a significant difference from the assessment of kidney HU,liver HU, and ureteral dilatation in the mineral water, furosemide, and black tea test groups with sig values.<0.05.Black tea increases Hounsfield Unit (HU) values in the kidneys,lungs,liver,and ureteral dilation, as a tracking picture shown in the Curved Multiplanar Reconstruction(MPR) application. This confirms that black tea can be used as a natural diuretic alternative for some reasons:effective, fast, easy, and inexpensive.It makes it easier to track kidney stones.The operation of curved multiplanar reconstruction(MPR) applications during reconstruction can display more optimal image results to support more accurate diagnostic information.

Keywords: black tea; Curved Multiplanar Reconstruction; diuretic; MSCT urography; kidney stones

1. Introduction

Kidney stones, known as nephrolithiasis or urolithiasis, occur when crystals or crystal concretions from the kidneys move through the genitourinary system (Alelign & Petros, 2018). Kidney stones are a common cause of problems in the urinary system, with cases increasing in recent years (Rukin et al., 2017; Sorokin et al., 2017). It is estimated that around 12% of the global population is affected by this condition (Nojaba & Guzman, 2023). Kidney stones that discharge in the urinary tract are generally characterized by symptoms of constant severe pain, which can occur in the waist and radiate to the groin (Corbo & Wang, 2019; Thakore &; Liang, 2023).

The rate of recurrence of kidney stones is quite high, ranging from 1.6%- 66.9% (Wang et al., 2022). Rule et al. (2014) found the rate of recurrence of this disease at different time intervals after the onset of symptoms for the first time: 11% (2 years), 20% (5 years), 31% (10 years), and 39% (15 years). The high cases of new and recurrent kidney stones are related to increased morbidity and economic burden (Hyams &; Matlaga, 2014; Sorokin et al., 2017). Some research results showed a relation between

kidney stones and an increased risk of chronic disease (cardiovascular disease (R. T. Alexander et al., 2014; Ferraro et al., 2013; Kim et al., 2020; Y. Liu et al., 2014; Peng & Zheng, 2017), chronic kidney disease (Rule et al., 2009; Sigurjonsdottir et al., 2015), hypertension (Kittanamongkolchai et al., 2017; Shang et al., 2017), metabolic syndrome (Y.-T. Liu et al., 2017), end-stage renal disease (Dhondup et al., 2018)), decreased quality of life (Jones et al., 2021; Modersitzki et al., 2014), even death (Dhondup et al., 2018; Whitehurst et al., 2019).

Kidney stones are a common and recurring condition, so it is important to consider the risk of radiation exposure to patients during diagnosis and treatment (Lipkin & Ackerman, 2016). Imaging methods should be used to minimize radiation and improve diagnostic accuracy. Some types of imaging modalities commonly used in evaluating disorders of the urological system are Blass Nier Overzicht (BNO-IVP), Ultrasound (USG), and Multislice Computed Tomography (MSCT) (Lampignano & Kendrick, 2017). Multislice Computed Tomography is one modality that can evaluate disorders of the urological system well because it has high sensitivity and specificity in detecting kidney stones (Hamimi & El Azab, 2016).

Examining MSCT urography requires patient preparation, such as fasting and drinking plenty of water to increase urine production. An increase in the volume of urine excreted by the kidneys is expected to meet the lumen of the urinary tract so that anatomical structures can be visualized and abnormalities can be assessed (Yudha et al., 2020). Using MSCT, evidence was found that water becomes a negative contrast medium that effectively produces image clarity and organ distension (Makarawo et al., 2013; Sulaksono et al., 2016). However, using water as a contrast medium will require a greater amount to fill the urinary tract lumen; the water secreted into urine is also less than water reabsorbed by the body (Lee et al., 2016). Not all hospitals use this method. Apart from water, some hospitals use furosemide to accelerate the increase in urine volume. However, it has contraindications such as furosemide allergy, anuria patients, kidney failure, hepatic coma, and hypokalemia (Khan et al., 2023). Moreover, furosemide is also known as a chemical diuretic that is feared to increase the workload on the kidneys as well as other side effects that arise, such as headaches, hyperglycemia, hypokalemia, blurred vision, and others (Khan et al.,2023). Thus, using natural ingredients as alternative diuretics is needed to minimize these effects. Tea is one of them.

Tea is rich in minerals that form enzymes in the body and support various metabolic processes, as well as antioxidants. Tea contains minerals such as calcium, magnesium, manganese, flavonoids, zinc, ferrum, potassium, and caffeine (Klepacka et al., 2021). The caffeine content in black tea causes an increase in blood flow to the kidneys by preventing the absorption of sodium, calcium, and magnesium, which stimulates urine production by the kidneys (Yudha et al., 2020). In the MSCT urography examination, a more detailed picture is essential to see the anatomy of the urinary system. Curved multiplanar reconstruction (MPR) is used in the image reconstruction process to show a more detailed picture if there is something abnormal in the urinary system. This study aimed to determine the effect of black tea as a diuretic alternative on urography MSCT examination and determine which is most effective in establishing the diagnosis of urography MSCT examination.

2. Research Methods

This study is Quasi-Experimental by carrying out a thorough analysis of the comparison of image results between those who use and without using black tea as an alternative diuretic, which includes renal HU values, HU Lien, Liver HU, ureteral dilatation, and Curved Multiplanar Reconstruction (MPR) imaging results. Respondents in this study consisted of 18 patients and three radiology doctors. The criteria for inclusion are outpatients with urography MSCT examination at RSUD dr. Soehadi Prijonegoro Sragen, Central Java, in March-May 2023, aged 45-60 years. The criteria for patient exclusion are uncooperative in the examination, having a history of kidney failure, and patients who are

installed with an IV infusion. The inclusion criteria for doctor respondents are radiology specialists with a minimum service period of 5 years.

Respondents previously signed an informed consent sheet prior to data collection. Patient respondents were grouped into the mineral water group, the 40 mg furosemide drug group, and the black tea group. Each group consisted of 6 patients. They must undergo fasting for four to six hours before the MSCT urography examination. One hour before, they should drink one glass of mineral water (250 ml), one glass of concentrated plain tea (250 ml), and 40 mg of furosemide according to each group. After that, patients entered a scanning process using MSCT 128 Slice in each group, then tracked MSCT urography with the curved multiplanar reconstruction (MPR) application. During that time, patients are forbidden to urinate until the examination is completed. In the final session, radiologists assess the results of MSCT tracking images for each group with a range of values of 1-5. Based on the results of the kappa test, the results of the image value of water and black tea got a kappa index value of 0.087 and 0.082, respectively, which confirms it has a very strong agreement closeness, while the results of the furosemide image value get a kappa index value of 0.067 which means it has a strong agreement closeness.

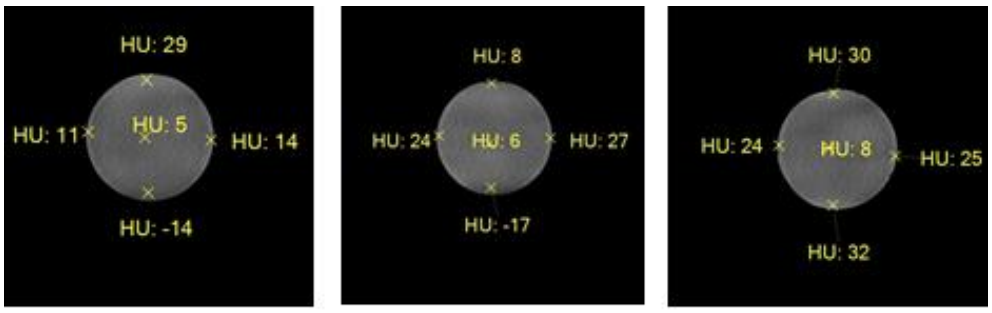
The data obtained in this study were ureteral dilation values, kidney Hounsfield Unit (HU) values, Liver HU values, HU Lien values, and MPR reconstruction results. The data that has been collected is then processed and analyzed. The results of the Shapiro-Wilk test showed normally distributed data, so to test the difference in mean (average) in the three categories of diuretic ingredients using the ANOVA statistical test. This research already has a letter of ethics from the Poltekkes of the Ministry of Health Semarang with Number 0825 / EA / KEPK / 2023.

3. Result and Discussion

3.1.Result

3.1.1. Scanning Result

This study used three diuretic ingredients: mineral water, furosemide drugs, and black tea. Before being inserted into the patient's body, it is tested In Vitro by placing it into a 250 mL glass, and then scanning is carried out so that image results are obtained, as shown in Figure 1.



(a) (b) (c)

Figure 1. Scanning InVitro Results (a) Water, (b) *Furosemide*, (c) Black Tea

One hour after each group of respondents was given mineral water, furosemide, and tea, MSCT urography scanning was then carried out. The results of urography MSCT scanning are in some appearances: axial, coronal, and sagittal slices, as shown in Figures 2, 3, and 4.

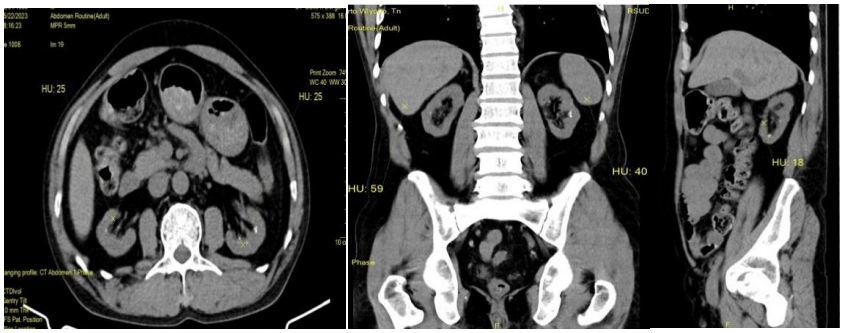


Figure 2. Results of MSCT urography scanning in patient 1 with preparation to drink mineral water

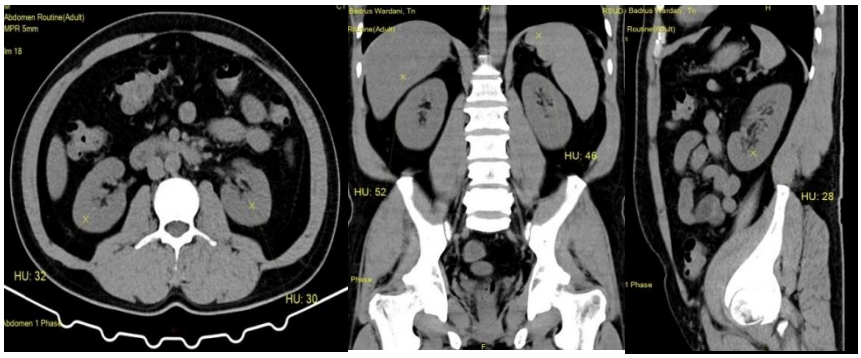


Figure 3. Results of urography MSCT scanning in patient 1 with preparation to drink furosemide

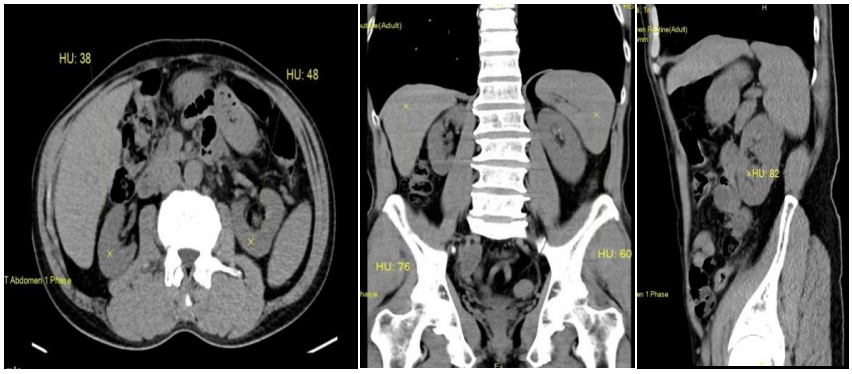


Figure 4. Results of MSCT scanning in patient 1 with preparation to drink black tea

3.1.2. Urography MSCT Tracking Results with Curved Multiplanar Reconstruction (MPR) application

Curved Multiplanar Reconstruction (MPR) was used to track MSCT urography in the mineral water, furosemide, and black tea groups. The results of the tracking picture appear in Figures 5, 6, and 7.

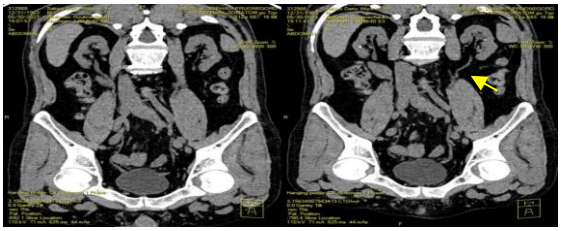


Figure 5. Results of tracking MSCT urography in patients with preparation to drink mineral water

*The arrow shows ureteral dilatation in patients drinking mineral water.

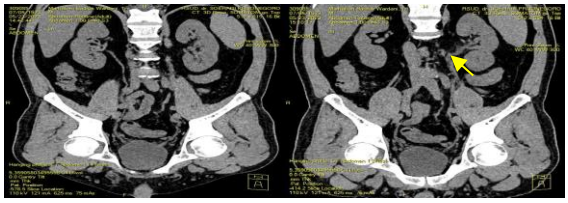


Figure 6. Results of tracking MSCT urography in patients with preparation to drink furosemide
*The arrow shows ureteral dilatation in patients drinking furosemide.

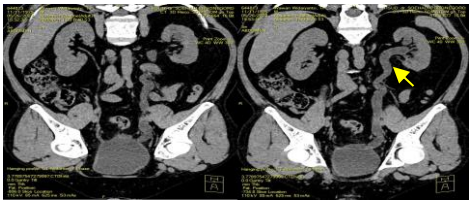


Figure 7. Results of tracking MSCT urography in patients with preparation to drink black tea
*The arrow shows ureteral dilatation in patients drinking black tea.

3.1.3. Results of Measurement of right and left renal HU values on MSCT urography

In this study, HU values of the right kidney and left kidney were measured. The results show the differences in the HU scores for each group. Table 1 explains that the HU values of the right and left kidneys in the black tea group were higher than in other groups.

Table 1. Hounsfield Unit (HU) of the right and left kidneys in patients drinking mineral water, furosemide, and black tea

Group	Name	HU Right Kidney	HU Left Kidney	Mean
Water	IMAGE 1	25	25	25
	IMAGE 2	36	37	36.5
	IMAGE 3	32	31	31.5
	IMAGE 4	31	31	31
	IMAGE 5	27	27	27
	IMAGE 6	31	32	31.5
Furosemide	IMAGE 1	32	30	31
	IMAGE 2	35	36	35.5
	IMAGE 3	30	27	28.5
	IMAGE 4	37	37	37
	IMAGE 5	35	40	36
	IMAGE 6	37	35	36
Black Tea	IMAGE 1	38	48	43
	IMAGE 2	50	51	50.5
	IMAGE 3	48	48	48
	IMAGE 4	45	45	45
	IMAGE 5	45	44	44.5
	IMAGE 6	40	39	39.5

Based on the ANOVA test, it was obtained a sig value of 0.000 < 0.05. The results explained a significant average difference between right kidney HU. They left kidney HU in the mineral water test group, furosemide test, and black tea test, as shown in Table 2.

Table 2. Test ANOVA Results: HU values of right and left kidneys in MSCT urography

Hounsfield Unit	Substance	F	Sig.
Right Kidney	Mineral water	21.273	0.000
	Furosemide		
	Black Tea		
Left Kidney	Mineral Water	19.954	0.000
	Furosemide		
	Black Tea		

3.1.4. Results of Ureteral Dilatation Measurement in MSCT Urography

Measurement of ureteral dilatation is carried out by measuring the value of the diameter of the ureter. Data on ureteral diameter in each group are shown in Table 3.

Table 3. Results of Ureteral Diameter Measurement

Group	Name	Diameter Ureter
Mineral Water	IMAGE 1	0.31 cm
	IMAGE 2	0.46 cm
	IMAGE 3	0.44 cm
	IMAGE 4	0.60 cm
	IMAGE 5	0.53 cm
	IMAGE 6	0.51 cm
Furosemide	IMAGE 1	0.52 cm
	IMAGE 2	0.51 cm
	IMAGE 3	0.46 cm
	IMAGE 4	0.50 cm
	IMAGE 5	0.43 cm
	IMAGE 6	0.48 cm
Black Tea	IMAGE 1	0.55 cm
	IMAGE 2	1.38 cm
	IMAGE 3	0.55 cm
	IMAGE 4	0.92 cm
	IMAGE 5	1.12 cm
	IMAGE 6	0.88 cm

The ANOVA test obtained a sig value of 0.020 < 0.05, which confirmed a significant mean difference between the diameter of the ureter in the water test group, furosemide test, and black tea test (Table 4).

Table 4. ANOVA Test Results of ureteral dilatation in MSCT urography

Substance	F	Sig.
Mineral water	5.170	0.020
Furosemide		
Black Tea		

3.1.5. Measurement Results of HU Values of Liver and Lien in MSCT urography

HU values in the liver and lien varied between groups. HU liver and HU lien were higher in the group that drank black tea than in the furosemide and mineral water groups, as shown in Table 5.

Table 5. Results of liver and lien HU values in each group

Group	Name	HU Liver	HU Lien
Air Mineral	IMAGE1	63	40
	IMAGE 2	57	46
	IMAGE 3	59	43
	IMAGE 4	60	35
	IMAGE 5	59	44
	IMAGE 6	53	42
	MEAN	58.5	41.6
Furosemide	IMAGE 1	52	46
	IMAGE 2	61	53
	IMAGE 3	56	52
	IMAGE 4	64	59
	IMAGE 5	61	50
	IMAGE 6	55	58
	MEAN	58.7	53
Teh Hitam	IMAGE 1	76	63
	IMAGE 2	74	57
	IMAGE 3	70	55
	IMAGE 4	70	60
	IMAGE 5	66	59
	IMAGE 6	72	60
	MEAN	71.3	59

Based on the ANOVA test, the sig value is 0.000 < 0.05. It can be concluded that there is a significant average difference between HU Lien in the water test group, furosemide test, and black tea test, as shown in Table 6.

Table 6. ANOVA Test Results of Lien value in MSCT urography.

Substance	F	Sig.
MineralWater	30.144	0.000
Furosemide		
Black tea		

3.2.Discussion

Black tea as an alternative to natural diuretics was applied in this research using curved multiplanar reconstruction (MPR), an examination of MCST image reconstruction. This curved multiplanar reconstruction (MPR) application produces a more optimal image to strengthen the diagnostic information generated (Gross et al., 2020; Sulaksono et al., 2016). The use of diuretic ingredients can provide optimal MSCT image tracking results. This study explained a significant difference from the assessment results of right kidney HU, left kidney HU, liver HU, and ureteral dilatation in the mineral water, furosemide, and black tea test groups with sig values. < 0.05.

Black tea is rich in flavonoids, alkaloids, and phenolics that can function as diuretics (Konieczynski et al., 2017; Meharie & Tunta, 2020). Caffeine is a compound that belongs to the group of alkaloids. The content of black tea has been tested at the Surakarta Goods Quality Testing and Certification Center. The results showed that black tea contains about 1.48% caffeine, alkaloids, flavonoids, and phenolics that inhibit the enzyme carbonic anhydrase in the renal tubules. They impede angiotensin-converting

enzyme (ACE) and increase the bioavailability of nitric oxide, prostacyclin, and bradykinin, thereby increasing diuresis. They also inhibit Na+/K+-ATPase (Huyut et al., 2016; Meharie & Tunta, 2020). (Welch, 2015). Flavonoids are one of the natural ligands that act as antagonists for adenosine A1 receptors (S. P. H. Alexander, 2006; Vargas et al., 2018). Diuresis and natriuresis induced by adenosine receptor antagonist type 1 (A1 -AR) A1 adenosine receptor antagonists impede Na+ and Cl- reabsorption. This can lead to an increase in the concentration of Na+ and water in the tubule, which results in an increase in the volume of urine and water in the tubule (Vargas et al., 2018). A1 adenosine receptor antagonists can maintain glomerular filtration rate by vasodilating the afferent arteries of the kidneys and stimulating blood flow in the kidneys, resulting in diuresis and natriuresis (Meharie & Tunta, 2020). Black tea has a rapid onset of diuretic effect (first 1 hour) (Abeywickrama et al., 2010).

Radiologists explain that in-vitro scanning results of mineral water, furosemide, and tea showed a higher HU value of tea than other groups on all four sides, so it can increase image enhancement because black tea also contains magnesium. They also add that the use of black tea can make a wider ureter diameter size and can fill the ureteral lumen well, making it easier when tracking. The black tea test group in this study experienced wider ureteral dilatation (seen from the diameter of the ureter) than other groups. According to Yudha et al. (2020), if the ureter is dilated or there is urine in the lumen of the ureter during the MSCT examination, it will clarify the image results and facilitate the assessment of overall urinary tract abnormalities. The density value of the urinary tract as a whole will decrease along with the large amount of urine produced by the kidneys that fill the lumen of the ureter to the urinary vesicles. This causes differences in the density of surrounding organs so doctors can assess and diagnose abnormalities that arise in the urinary tract (Fa'ik, 2018; Yudha et al., 2020).

4. Conclusion

This research showed a significant difference from the assessment results of right kidney HU, left kidney HU, liver HU, and ureteral dilatation in the mineral water, furosemide, and black tea test groups with sig values < 0.05. Black tea has an effect in MSCT urography examination, especially because black tea can be used as an alternative to natural diuretics, widen the diameter of the ureters, and facilitate tracking kidney stones through the application of curved multiplanar reconstruction (MPR) at the time of reconstruction. It proves that black tea is an effective, easy, inexpensive and fast natural diuretic alternative that can be used as a negative contrast medium in the examination pf MSCT urography.

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