Conference Paper

The Effect of Window Width and Window-level Settings in Non-enhanced Head CT to Increase the Diagnostic Value of Subacute Ischemic Stroke

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Abstract

Background: Non-enhanced head CT (NECT) was known as one of the modalities to assess subacute ischemic stroke. The values of window width (WW) and window level (WL) were influencing lesion conspicuity and diagnostic accuracy as well. The ability of physicians to detect parenchymal hypoattenuation depended on window width and window-level settings. **Objective:** To determine the best value of head NECT window width and window level in the subacute ischemic stroke. **Material and method:** Routine non-enhanced CT scanning was performed with the patient's head in a head holder with a 64 Slice MSCT Light speed (GE Medical Systems) in the hospital emergency department using the following non-helical scanning technique: 120 kV, 625 mA, and 5-mm section thickness. Twenty six values of window width and window level of subacute ischemic stroke were made and assessed by 28 experienced radiologist. We found the best value of 35 WW 25 WL. This value was significantly better than brain window ($p < 0.05$). **Conclusion:** In summary, we have demonstrated that the detection of subacute ischemic stroke with non-enhanced head CT scanning was facilitated by window width and window-level settings. The 35 WW 25 WL setting was recommended to increase the diagnostic value of subacute stroke infarct.

Keywords: non-enhanced head CT, subacute ischemic stroke, window width, window level

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1. Introduction

Stroke is a serious health problem that needs attention and special care because it can affect anyone, at any time, regardless of race, gender, or age [1]. In Indonesia, people with stroke rank the first in Asia and the fourth in the world, after India, China and America. Based on data taken from the Health Research in 2013, stroke is the leading cause of death in Indonesia. The prevalence of stroke in Indonesia is 12.1 per 1,000

populations. Compared to Riskesdas 2007, the number is rising to 8.3 percent. Stroke, then, has become a major cause of death in almost all hospitals in Indonesia with 14.5 percent of rate [1].

CT scan is an examination modality for identifying whether a stroke is caused by bleeding or clotting [2, 3]. CT scan is faster in execution than MRI. But in certain cases, MRI has its own advantages because it can capture the diffusion of fluid in the brain [2–7]. In Indonesia, the most advanced modalities owned by the hospital is a CT scan, especially in the peripheral areas that the majority still use a CT scan as the most advanced modalities to enforce diagnose [8, 9].

Stroke window is a method of setting the window width and window-level narrow windows which are specifically used to diagnose ischemic stroke [9–14]. Using a particular arrangement, the main image of the acute and subacute ischemic stroke can be clearly seen [15]. Nowadays stroke window is rarely used by the radiographer and radiologist to depict the portrait of ischemic stroke on the case of CT scanning the head without contrasting the diagnosis of ischemic stroke. Setting the value of the window width and window level especially in Indonesia has not been researched earlier. The recent studies show that the value of the corresponding window for ischemic stroke, done by P. J. Turner and G. Holdsworth (2011), mentions that the appropriate setting of window width and window level can detect ischemic lesions by increasing the sensitivity of gray and white matter [10].

2. Material and Method

The implementation of examining non-enhanced head CT Scan for patients who have been diagnosed with subacute ischemic stroke at the Airlangga University hospital is by using 64 Slice MSCT Light speed (GE Medical Systems) with 5mm in Slice Thickness parameters, 10.62 cm *Range*, 120 kV 625 mA of *Eksposi* Factor, FOV 19.1 cm, 0 degrees Gantry Tilt, Window Width, Window Level and Pitch of 0.531; 1. Subsequently, the various arrangement of window width (WW) and window level (WL) value is set. The arrangement of window width and window level starts from 8–40 WW grades and 20–40 WL so as to get 26 variations of the value of the window width and window level.

Data variation of the mentioned WW and WL were valued by 28 respondents, who are experienced radiologist, to find out the value of the window width and window level on the questionnaire sheet. The results of the questionnaire were consecutively tabulated and obtained for the best value of WL and WW. The next steps were doing the

research on comparative test of the second questionnaire using Likert scale compared to window width/window level and brain window to reinforce that the window width and window level obtained is able to increase the value of the diagnosis of subacute ischemic stroke cases. The results of the comparison test was then analyzed using SPSS for windows to reflect the significance, sensitivity, and image quality. The value of all the questions' item with each level of significant equals to (= 0.05). If the significance value less than 0.05 then Ho and H1 are accepted. Meanwhile, if the significance is greater than 0.05 then Ho and H1 rejected.

Table 1: Variation table of the research on window width and window level.

NILAI WW/WL	40 WW	35 WW	30 WW	25 WW	20 WW
40 WL	40/ 40	40/ 35	40/ 30	40/ 20	40/ 20
35 WL	35/ 40	35/ 35	35/ 30	35/ 25	35/ 20
30 WL	30/ 40	30/ 35	30/ 30	30/ 25	30/ 20
25 WL	25/ 40	25/ 35	25/ 30	25/ 25	25/ 20
20 WL	20/ 40	20/ 35	20/ 30	20/ 25	20/ 20
					8/20

3. Result

The result of the questionnaire showed 35.71% of the respondents who chose the window width and window level of 35 WL 25 WW. In the window width and window level, respondents rate the window as the best window to demonstrate subacute ischemic stroke. The other questionnaire results of the window width and window level, namely: (30WW 25WL = 14:28%), (30WW 20WL = 10.71%), (40 WW 30 WL = 10.71%), (40 WW 25 WL = 3.57%), (8 WW 20 WL = 3.57%), (20 WW20WL = 7:14%), (25 WW 30 WL = 7:14%), (30 WW 30 WL = 7:14%). They are illustrated in chart 1.

The data obtained from each of the normality test results, one-sample of Kolmogorov–Smirnov test, and statistical comparison test of paired simple test with *brain window*, are as follow: the item in question 1, compared the B image (Stroke

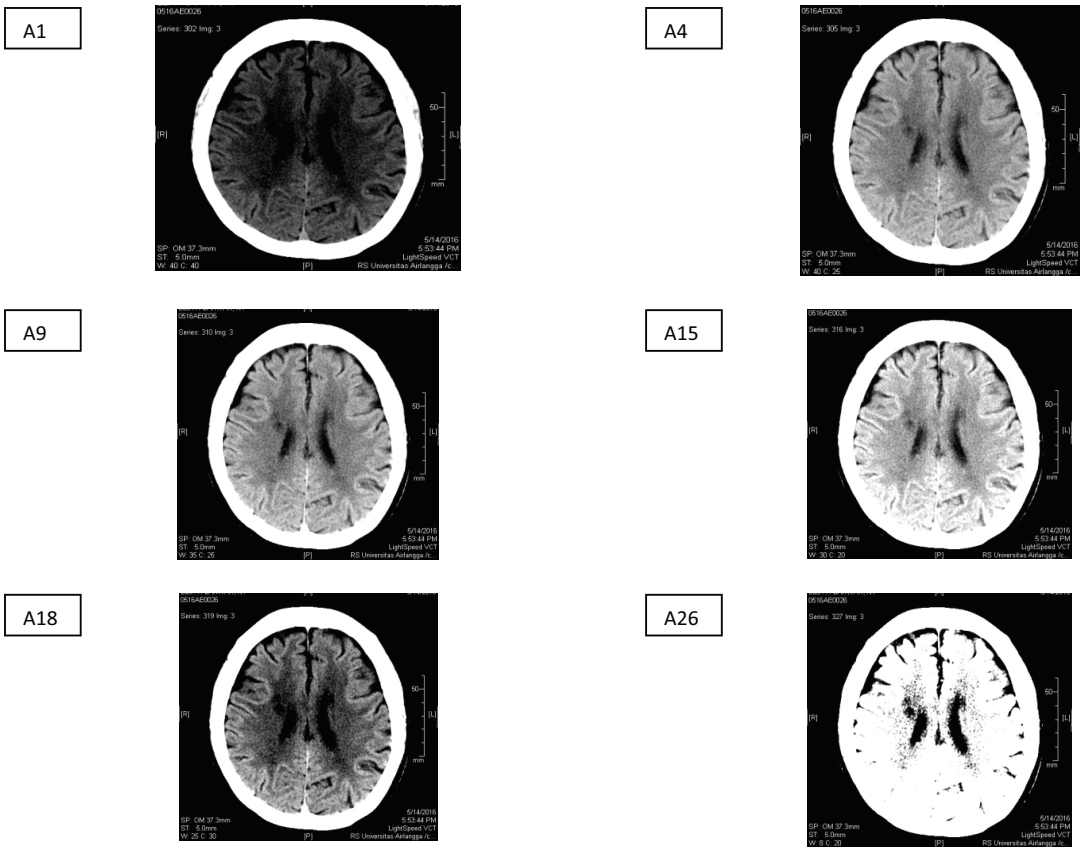

Figure 1: The result sample of window width and window-level arrangement.

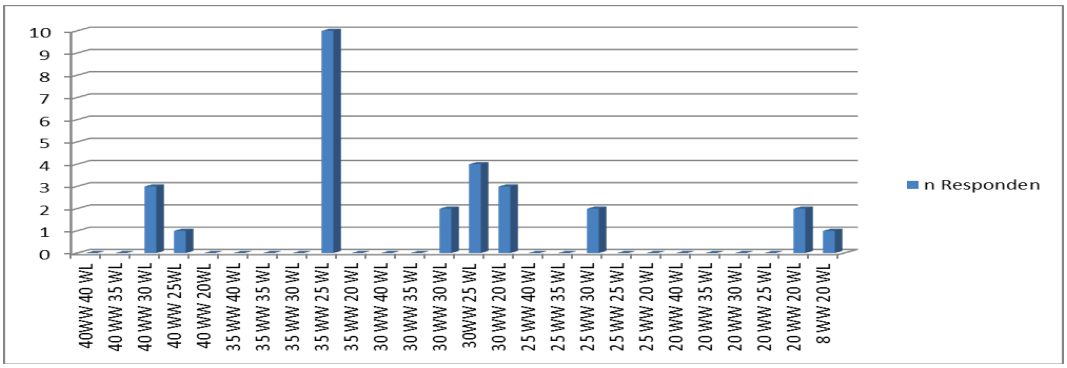

Figure 2: The respondents' assessment results of the window width and window-level variation.

Window) with the A image (Brain Window) which showed a significant result in manifesting the clarity of stroke infarct, results sig 0.184 (Ho is accepted); the item in question 2, compared the B image with the A image showed the contrast ratio between the infarct tissue and the brain parenchyma around it, looks fine p = 0.130 (Ho is accepted); the item in question 3, compared the B image and the A image showed higher Noise index that increased sensitivity to stroke infarction overview, shows p = 0.074 (Ho is accepted); the item in question 4, compared the B image with

Figure 3: The results of the CT scan image of non-contrast at 35 WW 25 WL.

the A image showed an increase in the value of diagnosis of stroke infarction cases, shows p = 0.184 (Ho is accepted); the item in question 5, compared the B image and the A image, shows a better stroke infarct, p = 0.074 (Ho is accepted). It is concluded that in this comparison test, Ho is accepted and H1 is declined, found some influences of the window width and window level to some increases of the diagnosis value as a result of head CT scan image without contrast of the subacute infarction case.

4. Discussion

This study aims to find the settings of window width and window-level narrow windows which are specifically used to diagnose stroke infarct for subacute in particular [4, 11, 12]. Nowadays stroke window is rarely used by radiographer or radiologist to display the picture of stroke ischemia on the case of head CT scan without contrast with the diagnosis of ischemic stroke [12, 14, 15]. The research conducted by P. J. Turner and G. Holdsworth (2011) mentions the value of window width and window level used is 40 WW and WL 40 which can be used to improve the diagnosis of subacute ischemic stroke [10]. Meanwhile Charlie Chia-Tsong Hsu (2010) states that the value of the window width and windows at 8 WW and 20 WL level can increase detection sensitivity of acute ischemic stroke with the sensitivity level of 71% of 57% of the normal *window* settings (80 WW/20 WL). It is not mentioned in these two studies, the parameters used in doing the examination. Some variations of the aforementioned stroke window show the different setting of stroke window [11].

This study results that 35 WW and 25 WL is the window width and window level of the highest (35.71%) chosen by the respondents on the CT scan without contrast of subacute ischemic stroke cases. In the earlier theory, there were few studies that searched the sensitivity of the value of the window width and window level to cases of stroke ischemia used as the earlier reference to determine the range of window

width and window-level research. The setting results of the best window width and window level in this study differs from the previous studies. This differences can be caused by the thickness, shape and size of the head. The thickness, shape and size of the head varies between countries depending on their race. It is based on a study carried out by Hong Kong, Polytechnic University – Faculty of Design, revealed that the size of a human head have a relationship with race. People of Mongoloid race, for example, has a relatively round head and flat around the crown while Caucasians tend to have oval and narrow head around the crown. The conclusion was based on a study of 2,000 volunteers in six cities. The shape and size of the head have the effect on the head density being CT scanned. Thus, there can be a difference in determining WW and WL (stroke window) from one to another country but somehow it still have a level of sensitivity and significance to diagnose stroke ischemia. In this study, researchers do not discuss further about the correlation between the size of the head and the density of head CT scan results for the scope of this research was limited to searching for the best value for WW and WL alone to assess subacute ischemic stroke.

The results of comparison test between brain window (80WW 40WL) and stroke window obtained (35WW 25 WL), showed that 35 WW 25 WL can increase the value of diagnosis as an image result of non-enhanced head CT scan in the case of subacute infarction.

5. Conclusion

The aforementioned study showed that the value of the window width and window level, 35WW 25WL can be used as a parameter of head CT scan without contrast to enhance the diagnostic value of subacute infarction stroke.

Conflict of Interest

None declared.

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