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Anatomical Information of Slice Thickness Variation in Ischemic Stroke with CT Scan

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ABSTRACT

Ischemic stroke causes partial or complete blockage of blood flow to the brain. Signs of ischemic stroke can be observed on CT scans of the head, namely Hyperdense Artery Sign (HAS) and parenchymal hypoattenuation. A CT scan can make the diagnosis by providing the desired anatomical information. The slice thickness of the CT scan examination of the head is 2-5 mm from the base of the cranium to the pars petroleum and 5-10 from the pars petroleum to the vertex, while in RSI Siti Rahmah Padang CT scan of the head in the case of ischemic stroke uses a slice thickness of 5 mm. Slice thickness is one of the significant parameters in providing anatomical information and good image quality. This research was conducted at RSI. Siti Rahamah from February to April 2023. Slice thickness variations start from 2 mm, 3 mm, 4 mm, and 5 mm. Descriptive qualitative research type. The research informants consisted of 5 radiology specialists. Data collection methods consisted of literature study, observation, interviews, and documentation. Data is processed using comparative, namely comparing the results of observations with existing theories in reference books through data reduction, data presentation, and conclusions. The results showed that the periventricular anatomy was visible at each slice thickness. The basal ganglia area is clearer at a 2 mm slice thickness, the sulci cerebrum is better at a 2 mm slice thickness, hippo lesion area is clear at a 2 mm slice thickness. The boundary between white matter and gray matter is clearer at 2 mm slice thickness, the pons and thalamus look the same at each slice thickness, and the head CT scan examination of ischemic stroke cases is better at 2 mm slice thickness.
Keywords: Slice thickness, Ischemic; Stroke, CT scan

BACKGROUND

Ischemic stroke is a blockage of a blood vessel that causes partial or complete cessation of blood flow to the brain. Ischemic stroke generally results from atherothrombosis of cerebral blood vessels, both large and small. In ischemic stroke the blockage can occur along the arterial blood vessel pathway leading to the brain. Signs of ischemic stroke that can be observed on a head CT scan are Hyperdense Artery Sign (HAS) and parenchymal hypoattenuation. HAS occurs due to the presence of a thrombus in the artery lumen characterized by a higher density than normal blood. (Mair et al, 2015).

Stroke has been one of the leading causes of death and disability globally (Feigin, 2021), and the lifetime risk of stroke has increased substantially by 50% over the past two decades (Feigin et al., 2022). The quality of stroke treatments is pertinent to life quality and social developments. For patients suffering from acute ischemic stroke (AIS), identifying early CT signs of AIS is critical for diagnosis, as even a delay of several minutes can lead to the death of neural cells. Early arterial recanalization and reperfusion potentially save the penumbra, which is the hypoxic brain tissue, and improve neural functioning. Non-contrast computerized tomography (NCCT) is the most commonly used medical imaging technique for assessing the severity of acute ischemic stroke (AIS) due to its wide availability and examination speed.

Acute ischemic stroke (AIS) occurs when the blood supply to the brain is interrupted due to the occlusion of an artery. For every hour that perfusion is not restored, the brain loses as many neurons as it does in almost four years of normal aging (Saver, 2006). Neuroimaging, particularly spatio-temporal (4D) Computed Tomography Perfusion (CTP), has been instrumental in the diagnosis and treatment decision-making of AIS patients (Yu et al., 2016). CT scan of the head can detect intra-cerebral hemorrhage, space occupying lesions (SOL), cerebral edema and changes in brain structure. CT Scan can also be used in identifying infarction, hydrocephalus and brain atrophy (Kamaruddin et al., 2022). As a supporting tool in making a diagnosis, a CT scan is expected to provide an informative picture, especially the desired anatomical information. In CT Scan imaging, slice thickness is one of the scan parameters that is quite significant in producing good CT Scan image quality (Kurniyanto, 2019).

Slice thickness is the thickness of the slice of the object being examined. The value is chosen according to the needs of a clinical. The thick size will produce images with low detail on the contrary with a thin size will produce high detail details this is because the thick thin use of slice thickness affects the volume of objects passed so that if the

volume passed is large then the information obtained is small and will cause the data received by the detector is also small and this applies vice versa when using a thin slice thickness. When the thickness increases, disturbing images such as lines will arise due to differences in density in the slices that are passed and if it is too thin the image will look not smooth (Catur, 2011).

From various theories, the head CT scan examination technique uses axial cuts with different slice thicknesses. The slice thickness used for CT scan examination of the head is 2-5 mm for the area from the base of the cranii to the pars petrosum and 5-10 for the area from the pars petrosum to the vertex (Bontrager, 2001). The selection of slice thickness for head examination varies depending on the type of pathology, including 1 mm for aneurysms, 3 mm for base skull tumors, 5 mm for routine brain examinations, 10 mm for hydrocephalus (Henwood,1999).

Baert (2009), to show a clear picture of the infarction suggested using a slice thickness of 3 mm. Baert (2011), also recommends using a reconstruction interval value smaller than the slice thickness size (50% of the slice thickness size) to show small lesions. While at RSI Siti Rahmah Padang CT head in ischemic stroke uses a slice thickness of 5 mm axial cut, without using thinner or thicker slice thickness reconstruction. This difference is why the authors are interested in conducting research on slicethickness variations in providing more informative diagnostic information in ischemic stroke cases with slice thickness variations of 2 mm, 3 mm, 4 mm, and 5 mm.

METHOD

This type of qualitative research with descriptive methods. conducted in the radiology installation of RSI Siti Rahmah Padang in February-April 2023 research informants amounted to 5 radiology specialists. The data collection method consists of a literature study by collecting data by understanding and studying theories from various literature related to the study, observation by observing directly to the radiology installation of RSI.Siti Rahmah regarding CT scan examination of stroke with clinical ischemic stroke using a slicethickness of 5 mm then the researcher reconstructs it to a slicethicness of 2 mm, 3 mm and 4 mm, the interview method is structured by using an interview guide where all questions are the same for all research informants. Data processing uses the data triangulation method to obtain data validity, namely by combining various data with existing sources, data analysis is carried out when data collection takes place interactively.

RESULT AND DISCUSSION

The following are the image results of slicethickness reconstruction of CT scan images of the head of ischemic stroke cases with variations of 2 mm, 3 mm, 4 mm, 5 mm on the anatomy of the ventricles, ganglia nation, sulci cerebri, hypodense lesions, firm boundaries of white matter and gray matter as well as thalamus and pons.

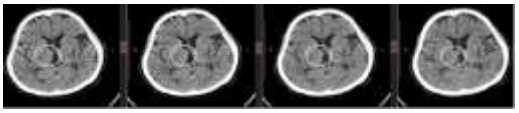

Figure 1. Right and left lateral ventricles

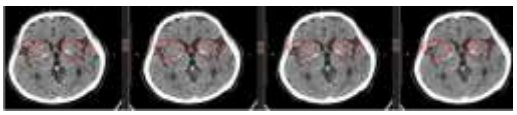

Figure 2. Bangsa Ganglia

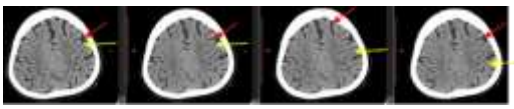

Figure 3. Sulci Cerebri

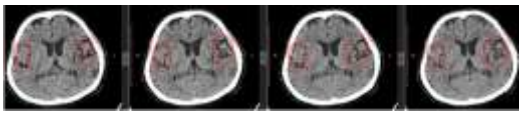

Figure 4. Lesi Hipodens

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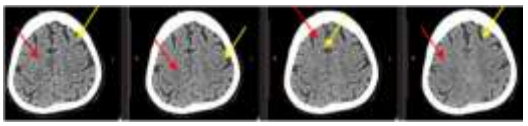

Figure 5. White matter and Grey Matter

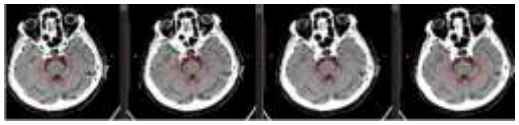

Figure 6. Pons

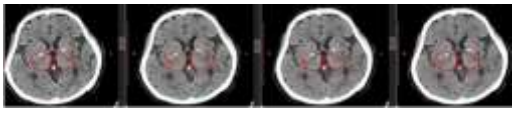

Figure 7. Thalamus

Table 1. Results of anatomical information analysis of slicethickness 2 mm, 3mm, 4mm, 5 mm

Anatomical Criteria	Informant's answer
Ventricles	The periventricular images produced through slicethickness reconstruction are the same with no difference because the ventricles have a considerable size.
Bangsa Ganglia	The basal ganglia image produced through slicethickness reconstruction is better at 2 mm slicethickness than thicker slice thickness because it can show a clearer structure.
Sulci Cerebri	The images of sulci cerebri produced by slicethickness reconstruction are similar but better at 2 mm slicethickness.
Lesi Hipoden	The image of the hippodense lesion produced through slicethickness reconstruction is better at 2 mm slicethickness, which can provide more information than thicker slice thickness
White matter & Grey matter	The image of white matter and gray matter through slicethickness reconstruction is better at 2 mm slicethickness can produce a firmer and clearer image
Thalamus & Pons	The image of the thalamus and pons through slicethickness reconstruction is the same, there is no difference because the thalamus and pons have a large enough size.

According to Bontragers (2018) Cerebral ventricles need to be identified on CT radiographs. The CT scan picture of ischemic stroke shows a symmetrical bilateral lateral ventricle shape, the size of the right and left lateral ventricles and ventricle 3 is dilated while ventricle 4 looks normal. The anatomical picture of the ventricles produced through slicethickness reconstruction is the same, there is no difference because the ventricles have a large enough size, this is in accordance with the statements of all informants, the results of observations, document review and the results of the picture.

Based on the research of Tomura et al (1988), the initial sign of ischemic infarction on CT scan is the blurring of the lentiform nucleus boundary. This is caused by sellular edema in the basal ganglion area. In the CT scan picture of this ischemic stroke, there are hippodense lesions with indistinct boundaries in the bilateral basal ganglia, physiological calcification in the pineal galandula area in the basal ganglia that appear normal. The anatomical picture of the basal ganglia produced through slicethickness reconstruction is better with a slicethickness of 2 mm than a thicker slice thickness because it can show a clearer structure, this is in accordance with the statements of 3 informants, the results of observations, document review and the results of the picture.

In the anatomy of the brain surface sulci are formed by folds of the cerebral cortex known as giri, between these giri there are grooves known as sulci that contain CSF (Bonttager's, 2018). In the CT scan picture of ischemic stroke, the sulci and gyri corticalis appear dilated. The anatomical image of the sulci cerebri produced through slicethickness reconstruction is almost the same but better with a slicethickness of 2 mm compared to a thicker slice thickness because it can show a clearer structure, this is in accordance with the statements of 2 informants, the results of observations, document review and the results of the picture.

According to Kamaruddin et al. (2021) lack of oxygen makes the tissue abnormal or even dead which causes the image display results to be blacker than normal tissue or often called hippodens. The CT scan picture of ischemic

stroke shows hippodense lesions in the bilateral basal ganglia area, and there are also multiple small hippodense lesions in the bilateral lateral periventricular area. The anatomical picture of the hippodens lesion area produced through slicethickness reconstruction is better with a slicethickness of 2 mm than a thicker slice thickness because it can provide a lot of information and precisely this is in accordance with the statements of all informants, the results of observations, document review and the results of the picture.

According to Bontragers, (2018) the CNS can be divided based on its appearance into white matter and gray matter, as cranial CT scans can distinguish between white matter and gray matter, passage through the cerebral nuclei provides a wealth of diagnostic information. White matter areas include the corpus collosum and centrum semiovale. Gray matter areas include the cerebral nuclei, thalamus, and cerebral cortex. CT scan images of ischemic stroke show a clear differentiation between white matter and gray matter, normally it should be able to distinguish the density of both anatomies. The anatomical features of the white matter and gray matter areas produced through slicethickness reconstruction are better with a slicethickness of 2 mm compared to a thicker slice thickness because it can produce a firmer and clearer picture of the diffirentiation.

In the CT Scan picture of ischemic stroke shows the anatomy of the thalamus and pons that appear normal with no abnormalities, if it has abnormalities it can show the presence of pathological densities such as hippodense lesions. The anatomical features of the thalamus and the pons produced through slicethickness reconstruction are the same, there is no difference because the thalamus and the pons have a fairly large size, this is in accordance with the statements of all informants, the results of observations, document review and the results of the picture.

Diagnostic information criteria assessed include ventricular images visible ventricles one, two and three located on axial cut 5, ventricle four can be seen on axial cuts 3 and 4, clearly visible basal ganglia can be seen on axial cut 5, showing sulci cerebri can be seen on axial cut 7, showing hippodense lesions can be seen on axial cuts 5 and 6 this depends on the location of the infarction, firm boundaries between white matter and gray matter can be seen on axial cut 7, visible thalamus and pons can be seen on cuts 3 and 2.

CONCLUSION AND SUGGESTION

Slice thickness that can provide more informative anatomical information in ischemic stroke cases at RSI Siti Rahmah Padang is 2 mm slicethickness. We recommend using 2 mm slicethickness to show a smaller infarct volume.

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