Diagnostic Accuracy of NCCT Scan with DWI MRI Taking it as a Gold Standard in Detection of Acute Ischemic Stroke

NOREEN RASHEED, SAIRA HAMID, FOUZIA RANI

ABSTRACT

Aim: To determine the diagnostic accuracy of NCCT Scan with DWI MRI taking it as a gold standard in detection of acute ischemic stroke.

Results: In this study, out of 237 cases, majority of the patients i.e., 59(24.89%) were between 31-50 years, mean and sd was calculated as 53.65±5.78 years, 132(55.70%) male and 105(44.30%) were females, frequency of acute ischemic stroke (on gold standard) reveals 68(28.69%), diagnostic accuracy of NCCT scan with DWI MRI taking it as a gold standard in detection of acute ischemic stroke, which shows 66(97.06%) true positive, 2(2.94%) had false positive, 165(97.63%) had true negative while 4(2.37%) had false negative, sensitivity, specificity, +ve predictive value, -ve predictive value and accuracy rate was computed as 97.06%, 97.63%, 94.29%, 98.80% and 97.47% respectively.

Conclusion: Diagnostic accuracy of NCCT Scan when compared with DWI MRI (being gold standard) for the detection of acute ischemic stroke reveals significantly higher diagnostic accuracy.

Keywords: Acute ischemic stroke, diagnosis, NCCT Scan, DW MRI, diagnostic accuracy

INTRODUCTION

Stroke is the third leading cause of death and the leading cause of disability worldwide and is associated with a tremendous cost burden to society.[1] Acute stroke is typically characterized by the sudden onset of a focal neurologic deficit, though some patients have a stepwise or gradual progression of symptoms. Common deficits include dysphasia, dysarthria, hemianopia, weakness, ataxia, sensory loss, and neglect. Symptoms and signs are unilateral, and consciousness is generally normal or impaired only slightly, except in the case of some infarcts in the posterior circulation[2].

In Pakistan, the incidence of stroke has not been well studied but the number is conservatively estimated as 350,000 per year[3] & prevalence of 22%[9].

Noncontrast CT (NCCT) is the current diagnostic modality for acute stroke due to its wide availability and presumed near-perfect sensitivity for acute intracerebral hemorrhage (ICH), the most important differential diagnosis to ischemic stroke[4]. The early signs of cerebral ischemia on CT scan have been well described in middle cerebral artery (MCA) strokes; they include hyperdense MCA artery sign and the MCA 'dot' sign, hypodensity of insular ribbon outline and basal ganglia, Loss of grey-white matter distinction in the cortical ribbon and lentiform nucleus and effacement of the sulcus[5]. The sensitivity of CT in acute ischemic stroke varies, depending on the imaging features of infarction, examination time from clinical onset, study population, and other variables,

----

Department of Radiology, B. V. Hospital, Bahawlpur
Correspondence to: Dr. Noreen Rasheed, Email: nndoc@hotmail.com

with sensitivity of 16% and specificity of 96% without contrast enhancements[4,6].

Diffusion imaging assesses the relative mobility of water molecules. In acute ischemic stroke, water is redistributed from the extracelluar to the intracellular space, thereby restricting water diffusion. The signal detected is high (bright) because water molecules cannot diffuse very far; while in normal healthy parenchyma, water diffuses more readily and the signal returned is lower (grey or black)[5]. Diffusion weighted magnetic resonance imaging (DW MRI) measures change in the local magnetic field attributable to restricted diffusion after cell death. MR involving diffusion weighted imaging (DWI) shows far greater contrast and is superior at highlighting tissue injury within minutes of a cerebral infarct (with a reported sensitivity and specificity of 100%[7]. While it takes hours to reach a diagnosis of ischemic stroke with conventional MRI, DWI imaging allows detection of the disease within minutes. Diffusion weighted MRI also detects lesions not usually identifiable with conventional MRI, and can discriminate between new and old strokes as well as between acute and chronic ones[8].

Diffusion-weighted imaging (DWI), allows visualization of acute strokes that range in age from a few hours to 1 week. This is especially helpful in stroke patients who present within 12 hours of symptom onset but, as compared to NCCT Scan, DWI MRI is costly and not easily available as well as time consuming. In our study we will determine sensitivity and specificity of NCCT in diagnosis of ischemic stroke taking DWI MRI as Gold Standard.

MATERIAL & METHODS

A total of 237 cases having age range 30-80 years of either gender fulfil the criteria for metabolic syndrome. Patients were selected from Outpatient Department with minor complaints as upper respiratory tract infection, fever etc were included in the study while patients with previous history of MI, liver problems (ALT>40IU, AST>40IU), renal insufficiency (serum creatinine >1.2mg/dl), medical record of rheumatic disease, UTI, positive urine dip stick test for haemoglobin, glucose, leukocytes or nitrites and taking lipid lowering therapy were excluded from the study. It was a Cross sectional study between Jan. 2013 to June 2013 conducted at Department of Diagnostic Radiology, Bahawal Victoria Hospital, Bahawalpur. Name, age and hospital registration number was recorded on proforma attached. After taking informed consent, NCCT was performed under supervision by supervisor. The CT Protocol were followed. After that Diffusion weighted images of all the patients presented with focal neurological deficit were performed on a 1.5-Tesla Signa Magnet by researcher (me) under supervision of supervisior. Diffusion-weighted images were obtained with single-shot EPI using the following protocol: Repetition time: 6,000 ms, Echo time: 118 ms, Field of view: 40×20cm, Matrix size: 256×128 pixels, Section thickness: 6 mm, with 1-mm gap, Gradient strength: 14mT/m, b values: 1,221 and 4 sec/mm2 (six gradient directions and three signals acquired) and Image acquisition time: 126 seconds. Findings like bright signals on DW1 and low signals on ADC maps were recorded and assessment was made within an hour of these scans.

The collected data was entered in SPSS software (version 13.0). Mean±SD was computed for quantitative variable i.e., age and sex was presented as frequency and percentage. Sensitivity, specificity, positive predictive value (PPV), negative predictive value (NPV) and accuracy was calculated of NCCT taking DWI MRI as gold standard (using 2 x 2 table).

RESULTS

A total of 237 cases fulfilling the inclusion/exclusion criteria were enrolled to determine the diagnostic accuracy of NCCT Scan with DWI MRI taking it as a gold standard in detection of acute ischemic stroke.

In this study, we recorded 23(9.70%) between 12-30 years, 59(24.89%) between 31-50 years, 87(36.71%) between 51-70 years and 68(28.70%) were 71-80 years, mean and sd was calculated as 53.65+5.78 years (Table 1).

Table 1: Age distribution (n=237)

Age (in years)	n	%age
12-30	23	9.70
31-50	59	24.89
51-70	87	36.71
71-80	68	28.70

Mean+SD: 53.65+5.78

Table 2: Gender distribution (n=237)

Gender	n	%age
Male	132	55.70
Female	105	44.30

Table 3: Frequency of acute ischemic stroke (on gold standard) (n=237)

Acute Ischemic stroke	n	%age
Yes	68	28.69
No	169	71.31

Table 4: Diagnostic accuracy of NCCT Scan with DWI MRI taking it as a gold standard in detection of acute Ischemic stroke (n=237)

NCCT Scan	Acute Ischemic Stroke (On DWI MRI as Gold standard)		Total
Positive	True +ve (a) 66(97.06%)	False +ve (b) 4(2.37%)	a + b 70(29.54%)
Negative	False -ve (c) 2(2.94%)	True -ve (d) 165(97.63%)	c + d 167(70.46%)
Total	a+c 68(59.48%)	b+d 169(71.31%)	237(100%)

Gender distribution of the patients was done which shows 132(55.70%) male and 105(44.30%) were females (Table 2). Frequency of acute ischemic stroke (on gold standard) reveals 68(28.69%) while 169(71.31%) were not declared as acute ischemic stroke (Table 3). Diagnostic accuracy of NCCT scan with DWI MRI taking it as a gold standard in detection of acute ischemic stroke, which shows 66(97.06%) true positive, 2(2.94%) had false positive, 165(97.63%) had true negative while 4(2.37%) had false negative, sensitivity, specificity, positive predictive value, negative predictive value and accuracy rate was computed as 97.06%, 97.63%, 94.29%, 98.80% and 97.47% respectively (Table 4). Sensitivity: 97.06%, specificity: 97.63%, Positive predictive value: 94.29%, Negative predictive value: 98.80%, accuracy rate: 97.47%.

DISCUSSION

Stroke is a global health problem and is one of the leading causes of mortality and morbidity in adult. Noncontrast CT (NCCT) is the current diagnostic modality for acute stroke due to its wide availability

and presumed near-perfect sensitivity for acute intracerebral hemorrhage (ICH), the most important differential diagnosis to ischemic stroke[4].

There is no consensus on how the reliability and predictive ability of noncontrast computed tomography (NCCT) and computed tomography angiography source image (CTASI) change over time from acute ischemic stroke onset.

We planned this study to determine sensitivity and specificity of NCCT in diagnosis of ischemic stroke taking DWI MRI as Gold Standard.

In this study the results revealed that majority of the patients i.e., 59(24.89%) were between 31-50 years, mean and sd was calculated as 53.65±5.78 years, 132(55.70%) male and 105(44.30%) were females, frequency of acute ischemic stroke (on gold standard) reveals 68(28.69%), diagnostic accuracy of NCCT scan with DWI MRI taking it as a gold standard in detection of acute ischemic stroke, which shows 66(97.06%) true positive, 2(2.94%) had false positive, 165(97.63%) had true negative while 4(2.37%) had false negative, sensitivity, specificity, positive predictive value, negative predictive value and accuracy rate was computed as 97.06%, 97.63%, 94.29%, 98.80% and 97.47% respectively.

The findings of the current study are showing comparable results of MR involving diffusion weighted imaging (DWI) which shows far greater contrast and is superior at highlighting tissue injury within minutes of a cerebral infarct (with a reported sensitivity and specificity of 100%[7].

Vu D and co-worker[10] are of the view that non-contrast head CT has an important role in the work-up of acute stroke by excluding intracranial hemorrhage and by directly visualizing the parenchymal changes of early infarct. However, noncontrast CT has limited sensitivity and moderate interobserver variability in detecting early infarcts. We agree with the findings that that NCCT has an important role in the work-up of acute stroke but the findings are inconsistent regarding limited sensitivity, as we recorded a higher sensitivity, and diagnostic accuracy. The limitation of the reference study was that they did not report the percentage of sensitivity.

Gaskill-Shipley MF[11] reported that although new imaging techniques such as MR perfusion/diffusion and xenon CT have shown considerable promise in the detection of early brain ischemia, noncontrast CT remains the primary imaging test for the evaluation of acute stroke. It is fast, reliable, readily available, and continues to be used for all major stroke therapy trials.

Despite its limitations, CT is an accurate method of screening patients prior to thrombolytic therapy.

However, considering the above facts we recommend that more studies should be carried out to determine the diagnostic accuracy of NCCT in diagnosing the morbidity, so that fast, reliable, readily available technique may be used to detect for all major strokes.

CONCLUSION

We concluded that diagnostic accuracy of NCCT Scan when compared with DWI MRI (being gold standard) for the detection of acute ischemic stroke reveals significantly higher diagnostic accuracy.

REFERENCES

1. Heron MP, Hoyert DL, Murphy SL. National Vital Statistics Reports.2009;57(14):1–15.
2. H. Bart van der Wrop, MD, PhD, and Jan van Gijn, FRCP. Acute Ischemic Stroke. N Engl J Med 2007;357:572-79.
3. Khealani BA, Wasay M. Stroke in Pakistan. Intern Jour Stroke (in press 2008).
4. http://www.neurology.org/search?author1=P.D.+Schelli nger&sortspec=date&submit" Schellinger PD, 1Bryan RN, 1Caplan LR, 1Detre JA, 1Edelman RR, Jaigobin C. Evidence-based guideline: The role of diffusion and perfusion MRI for the diagnosis of acute ischemic stroke. Neurology.Jul 13, 2010; 75(2):177-85.
5. Dhamija RK, Donnan GA. The role of neuroimaging in acute stroke. Ann Indian Acad Neurol.2008;11:12-23.
6. Chalela JA, kidwell CS, Netwich LM.(January 2007). "Magnetic resonance imaging and computed tomography in emergency assessment of patients with suspected acute stroke: a prospective http://www.pubmedcentral.nih.gov/articlerender.fcgi?to ol=pmcentrez&artid=1859855"comparison"Lancet 369 (9558):293-8.
7. Tan PL, King D, Durkin CJ,Meagher TM, and Brilley D. Diffusion weighted magnetic resonance imaging for acute stroke: practical and popular. Postgrad Med J. 2006;82(966):289–92.
8. Tonarelli L. Diffusion-Weighted MRI of Ischemic Stroke. CEwebsource.com Expires October 15, 2012. Available at: http://www.cewebsource.com/ course PDFs/ DW-MRIIschemic Stroke.pdf
9. Wasay M, Kaul S, Menon B. Ischemic Stroke in Young Asian Women: Risk Factors, Subtypes and Outcome. Cerebrovasc Dis 2010;30:418-22.
10. Vu D, Lev MH. Noncontrast CT in acute stroke. Semin Ultrasound CT MR. 2005;26(6):380-6.
11. Gaskill-Shipley MF. Routine CT evaluation of acute stroke. Neuroimaging Clin N Am. 1999;9(3):411-22.