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MRI VERSUS CT: THE SUCCESSOR AND PREDECESSOR IN HYPER ACUTE / ACUTE STROKE

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ABSTRACT: INTRODUCTION: Stroke occurs due to impairment in blood supply to the brain, due to a hemorrhagic or ischemic insult. Acute/hyper acute stroke are difficult to detect on initial NECT. The characteristic changes when present are not prominent hence poorly detected on initial CT. The advent of MRI with DWI has greatly improved accuracy rates in detecting acute stroke. In spite of the benefits of MR over NECT, most patients with features of hyperacute / acute stroke are referred for NECT, as the initial modality of choice, since the awareness of MRI, in acute stroke during the golden hours has not been widely practiced. Hence this study is being conducted to create an awareness about the role of MRI in hyperacute/acute stroke in establishing a working protocol for referring consultants and to document the superiority of MRI over CT. **STATEMENT OF THE PROBLEM:** Patients with features of hyperacute/acute stroke are often not detected on initial NECT scans, due to defects in windowing and time taken for infarcts to show up on CT, resulting in inability to provide thrombolysis. **PURPOSE OF THE STUDY:** The study is a retrospective comparative study to establish the superiority of DWI over NECT in accurate detection of acute/hyperacute stroke and in creating awareness and formulating a working protocol for referring doctors. **MATERIALS AND METHODOLOGY:** 100 patients with features of stroke referred for CT and MRI imaging have been taken for the study. Patients subjected to CT were later referred for MR. The results obtained were subjected to radiological interpretation. **INCLUSION CRITERIA:** Patients referred for CT and MR with clinical features pertaining to acute/hyper acute stroke. **EXCLUSION CRITERIA:** Patients with imaging features discordant with acute stroke/hyper acute stroke. **RESULTS:** Of 100 patients only 20 could be detected by initial CT, and the remaining 80 were detected by MR. **CONCLUSION:** The detection of acute/hyperacute stroke has always proved to be a diagnostic challenge both for the clinician and the radiologist, the use of DWI has greatly enhanced detection rates in acute/hyperacute stroke. Thus in a patient with acute/hyper acute stroke, it is highly recommended that DWI should be used as the initial modality for evaluation, since it aids in accurate detection.

KEYWORDS: MRI-Magnetic Resonance Imaging, CT- Computed Tomography, DWI-Diffusion Weighted Image, Flair - Fluid Attenuated Inversion Recovery, GRE-Gradient Recalled Echo, ADC- Apparent Diffusion Coefficient, SAH- Sub Arachnoid Hemorrhage.

ABBREVIATIONS: DWI: Diffusion weighted imaging; NECT: Non enhanced computed tomography; MR: Magnetic resonance imaging.

INTRODUCTION: Accurate and prompt diagnosis of acute/hyper acute stroke is important as it can significantly influence patient mortality and morbidity. Stroke occurs due to impairment in the blood supply to the brain as a result of an ischaemic or haemorrhagic insult. In the past few decades, the number of elderly individuals with acute stroke has been steadily increasing.^(1,2)

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Neuroimaging has proved to play a pivotal role in diagnosis and treatment of hyperacute/acute stroke. CT findings are a wedge shaped hypodensity, with or without a hyperdense vessel, with loss of insular cortex.⁽³⁾ These changes when present are subtle. The advent of MRI with diffusion-weighted imaging has greatly improved accuracy rates in detecting patients with hyperacute/acute stroke (73% sensitivity, 92-97% specificity). In spite of the documented added benefits of MRI over CT,^(4,5,6) majority of patients in many urban cities suspected to have a stroke attack are still being referred for non-enhanced CT as the initial modality of choice. Hence this is a retrospective study, to create awareness about the role of MRI in hyperacute/acute stroke, to formulate a working protocol among referring consultants and budding doctors and to evaluate the superiority of MRI over CT in hyperacute/acute stroke.

MATERIALS AND METHODOLOGY: CT and MRI images of 100 patients with clinical suspicion of acute/hyperacute stroke from CHETTINAD HOSPITAL AND RESEARCH INSTITUTE were included in the study. Patients were initially referred for CT imaging and later the same set of patients was referred for MR imaging. CT imaging was performed using a 6 slice PHILIPS scanner and a 128 slice INGENUITY CORE PHILIPS scanner. MR imaging was done using a 1.5 Tesla SIGNA GE HDxt MR scanner. The images obtained were subjected to radiological analysis and interpretation.

Selection Criteria:

Inclusion Criteria: Patients referred for imaging with clinical features pertaining to hyperacute/acute stroke.

Exclusion Criteria:

1. Patients with cerebral abscess.
2. Patients with postictal paralysis.
3. Patients with hypoglycaemic/hyperglycaemic states.
4. Patients with metabolic encephalopathies.

RESULTS: 100 patients with clinical suspicion of stroke were subjected to CT and MR imaging, out of which CT was able to detect 20 patients and the remaining 80 were picked up by MR imaging.

Three radiologists with experience in CT and MR imaging were included in the study, the time taken for each radiologist to interpret a CT and MR and the number of infarcts detected by CT and MR were compared.

Statistical analysis was carried out using the analysis of variance model (ANOVA), using the SPSS (Version-21) software.

MODALITY	MEAN TIME(Sec)	SIGNIFICANCE
CT	424.6	.00137
MRI	3.2	
Table 1		

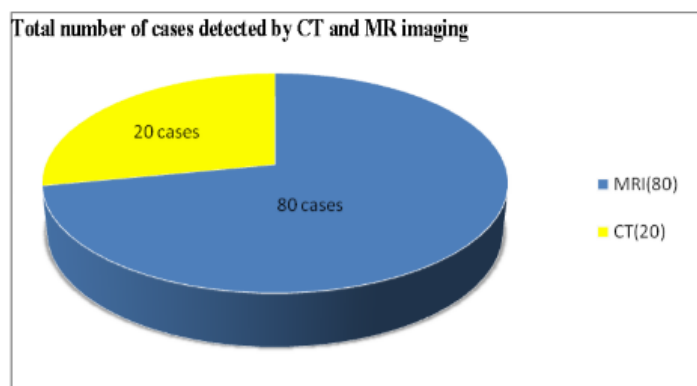
Table 1: Denotes the time taken by the radiologists to interpret a CT and MR, wherein, the radiologist were able to detect the ischaemic changes more rapidly with MR than CT, with statistical analysis revealing a highly significant P value.

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MODALITY	Percentage of infarcts detected	SIGNIFICANCE
CT	77.4	.00296
MRI	93.8	

Table 2

Table 2: Denotes the percentage of infarcts detected by CT and MR, wherein MR was able to detect more number of acute infarcts than CT, with statistical analysis showing a significant P value.



DISCUSSION: Given the restrictive time window for thrombolytic therapy, early diagnosis and management of acute stroke is vital in reducing mortality and morbidity in affected patients.

MR imaging play an important role in improving patient survival rates by prompt diagnosis if identified within 3 hours of onset of symptoms.⁽⁷⁾

The results of the present study have revealed that MR imaging is superior to CT in detection of hyperacute/acute ischaemic stroke lesions, especially using the diffusion weighted imaging sequence. Tobi Pledger in the year, 1986, has reported the importance of DW imaging in detecting hyperacute/acute stroke lesions. DW imaging is based on the Brownian principle of random movement of water molecules. In case of a hyperacute/acute stroke lesion there is restriction of movement of water molecules and hence these areas are identified as bright signal intensities instantly on MR imaging. Diffusion weighted imaging in conjunction with ADC mapping can also be done to calculate the age of infarcts accurately.

The results of the present study are comparable with the studies done by K. J. Van Everdingen MD et al in which the role of DW sequence in acute stroke has been emphasized.⁽⁸⁾

Studies done by several authors have also revealed the importance of DW imaging in acute ischaemic strokes.^(9,10,11)

Apart from ischaemic strokes, haemorrhagic strokes account for about 20% of stroke attacks. Traditionally non contrast CT was considered as the gold standard for the diagnosis of haemorrhagic strokes, this is because of its widespread availability, ability to diagnose SAH better than MR and less time required for image acquisition. But since the last few years, there has been increasing evidence indicating the ability of new MRI sequences in detecting not only hyperacute ischaemic strokes but also haemorrhagic strokes and haemorrhagic transformations.^(5,12,13, and 14)

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MR imaging has also progressed from parenchymal to penumbral imaging with several advantages over CT such as its use in diffusion perfusion mismatch with which potentially salvageable tissue at risk (Penumbra), can be identified, which is very important in thrombolysis,^(9,15) and its inherent ability to diagnose posterior circulation strokes better than CT,⁽⁴⁾ coupled with the absence of ionizing radiations.

As with other radiological modalities MR has its limitations which include, long image acquisition times, lack of universal availability and high cost factor. To hasten imaging speeds, newer MR imaging techniques are being developed such as combining EPI with Parallel imaging techniques.⁽¹⁶⁾ The sensitivity encoding technique (SENSE) is also being currently evaluated through which parenchymal and vascular comprise can be interpreted rapidly.⁽¹⁷⁾ Using these techniques it is possible to achieve a comprehensive stroke protocol that includes Diffusion weighted imaging(DWI), FLAIR, GRE, MR-Angiogram and MR-Perfusion imaging within a time interval of 6 minutes, thus equalling the time taken for a CT stroke protocol.⁽¹⁶⁾

In view of availability, In spite of conventional CT being widely available, the availability of multimodality CT scanners is limited resulting in many infarcts being missed on initial CT and though CT appears to be cost-effective in short term, "additional data are needed before the long term cost effectiveness is ascertained".⁽¹⁸⁾

With advances in imaging technology, techniques such as functional state resting MRI using the blood oxygenation level dependent signals (BOLD) can also be used to identify perfusion defects without the need for contrast administration.⁽¹⁹⁾ Special sequences such as MR-Spectroscopy can also play a role in acute stroke where an elevated lactated level can represent an ischaemic zone at risk of infarction.⁽²⁰⁾

The main complication of an acute stroke is hemiparesis (85% of ischemic strokes), to prevent this, an accurate and rapid diagnosis using MR imaging within the crucial period, is essential.

CONCLUSION: From the study we postulate that MR imaging can be used as the initial modality of choice in patients with hyperacute/acute stroke since it provides all the necessary and relevant diagnostic information.

REFERENCES:

1. Hollander M, Koudstall PJ, Bots ML, Grobbee DE, Hofman A, Breteler MMB (2003) Incidence, risk, and case fatality of first ever stroke in the elderly population, the Rotterdam study', J Neurol Neurosurg Psychiatry, 74, pp. 317-321 [Online]. Available at: <http://jnnp.bmj.com/content/74/3/317.full.pdf>.
2. Provenzale JM, Reza Jahan, Naidich TP, Fox AJ. (2003) 'Assessment of the patient with hyperacute stroke, imaging and therapy.' RSNA Radiology, 229(2), pp. 347-359 [Online]. Available at: <http://pubs.rsna.org/doi/pdf/10.1148/radiol.2292020402>.
3. Tomandl BF, Ernst Klotz, Dipl Phys, Rene Handschu, Brigitte Stemper, Frank Reinhardt. Comprehensive Imaging of Ischemic Stroke with Multi section CT. RSNA 2003; 23(3): 1-22. <http://pubs.rsna.org/doi/full/10.1148/rg.233025036>.
4. Rath GR, Marathe VN, Gandage SG, Kachewar SG. MRI evaluation of ischemic Lesions of Brain. International J. Healthcare & Biomedical Research. 2013; 1(3): 203-209. <http://ijhbr.com/pdf/203-208.pdf>.

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5. Schellinger P. D, OlavJansen, Fiebach J. B, Olivia Pohlers, Henning Ryssel, Sabine Heiland et al. Feasibility and practicality of MR imaging of stroke in the management of hyperacute cerebral ischemia. *AJNR* 2000; 21: 1184-1189. <http://www.ajnr.org/content/21/7/1184.full>.
6. Kidwell CS, Chalela JA, Saver JL, Sidney Starkman, Hill MD, Demchuk AM et al. Comparison of MRI and CT for detection of acute intracerebral hemorrhage. 2004; 292: 1823-1830. www.jama.com.
7. Albers GW. Expanding the window for thrombolytic therapy in acute stroke, the potential role of acute MRI for patient selection. *Stroke* 1999; 30(10): 2230-2237. <http://stroke.ahajournals.org/content/30/10/2230>.
8. Van everdingen K. J, Van der grond. J, KappelleL. J, RamosL.M.P, Mali W. P. T. M. Diffusion-weighted magnetic resonance imaging in acute stroke. *stroke* 1998; 29: 1783-1790. <http://stroke.ahajournals.org/content/29/9/1783.full.pdf>.
9. Karonen J. O, Yawa L U, Vanninen RL, Ostergaard Lelf, Kaarlina Paratanen P. L, Valnlo P. A et al. Combined Perfusion and diffusion weighted MR imaging in acute ischemic stroke during the 1st week. *RSNA* 2000; 217(3): 886-894. <http://pubs.rsna.org/doi/full/10.1148/radiology.217.3.r00dc02886>.
10. Lansberg MG, Norbash AM, Marks MP, Tong DC, Moseley ME, Albers GW. Advantages of adding diffusion weighted imaging to conventional magnetic resonance imaging for evaluating acute stroke. *JAMA NEUROLOGY* 2000; 57(9): 1311-1316. <http://archneur.jamanetwork.com/article.aspx?articleid=777526>.
11. Schaefer PM, Ellen Grant. P, Gilberto Gonzalez R. Diffusion-weighted MR imaging of the brain. *RSNA* 2000; 217(2): 331-345. <http://pubs.rsna.org/doi/abs/10.1148/radiology.217.2.r00nv24331>.
12. Ho Sung Kim, Deok Hee Lee, Chang Woo Ryu, Jeong Hyun Lee, Choong Gon Choi, Sang Joon Kim. Multiple cerebral microbleeds in hyperacute ischemic stroke: Impact on prevalence and severity of early hemorrhagic transformation after thrombolytic treatment. *American Journal of Radiology* 2006; 186: 1443-1448. <http://www.ajronline.org>.
13. Kidwell CS, Max Wintermark. Imaging of intracranial haemorrhage. *Lancet Neurol* 2008; 7:256-267. [http://www.thelancet.com/journals/lanneur/article/PIIS1474-4422\(08\)70041-3/fulltext](http://www.thelancet.com/journals/lanneur/article/PIIS1474-4422(08)70041-3/fulltext).
14. Marie-Cecile Arnould, Grandin BC, Andree Peteers, Guy Cosnard, Duprez TP. Comparison of CT and three MR sequences for detecting and categorizing early (48 Hours) hemorrhagic transformation in hyperacute ischemic stroke. *American Journal of Neuroradiology* 2004; 25: 939-944. <http://www.ajnr.org/content/25/6/939.full>
15. Schellinger P. D, Bryan R. N., Caplan L. R., Detre J. A., Edelman R. R., Jaigobin C et al. Evidence based guideline: the role of diffusion and perfusion MRI for the diagnosis of acute ischemic stroke. 2010; 177-183. <http://www.guidelines@aan.com>.
16. NaelK, Khan R, Choudhry G, Meshkshar A, Villablanca P, Tay J et al. Six-minute magnetic resonance imaging protocol for evaluation of acute ischemic stroke: pushing the boundaries.. *strokeaha* 2014; 45(7): 1981-1985. <http://stroke.ahajournals.org/content/early/2014/06/10/STROKEAHA.114.005305.abstract>
17. King JMU, Trivedi RA, Graves MJ, Harkness K, Eales H, Joubert I et al. Utility of an ultrafast magnetic resonance imaging protocol in recent and semi-recent strokes. *J NeurolNeurosurg Psychiatry* 2005; 76: 1002-1005. <http://jnnp.bmj.com/content/76/7/1002.full>.

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18. Lakshmi Narasimhan, Is multimodal CT superior to MRI in imaging acute ischemic stroke? no, Available at: <http://comtecmed.com/cony/2013/Uploads/Editor/Ranganathan.pdf>.
19. Aronen H. J, Korvenoga A, Martinkauppi S, Perkio J, Karonen J, Carlson S. Clinical applications of functional magnetic resonance imaging. INTERNATIONAL JOURNAL OF BIOELECTRO MAGNETISM 1999; 1(1): 23-24.
http://www.ijbem.org/volume1/number1/pdf/ijbem_a23-34.pdf
20. Gillard JH, Barker PB, Van Zijl PC, Bryan RN, Oppenheimer SM. Proton MR spectroscopy in acute middle cerebral artery stroke. AJNR 1996; 17: 873-886.
<http://www.ajnr.org/content/17/5/873.abstract>.

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