Section: Radiodiagnosis

Original Research Article

EVALUATING THE DIAGNOSTIC PERFORMANCE OF CT AND MRI IN NEUROLOGICAL DISORDER ASSESSMENT: A RETROSPECTIVE STUDY

Received : 13/12/2023
Received in revised form : 20/01/2024
Accepted : 03/02/2024

Keywords:
Magnetic Resonance Imaging, Computed Tomography, Stroke, Dyslipidaemias, Hypertension.

Corresponding Author:
Dr. Manisha Vasava,
Email: manishavasava14@gmail.com

DOI: 10.47009/jamp.2024.6.1.190

Source of Support: Nil,
Conflict of Interest: None declared

Int J Acad Med Pharm
2024; 6 (1); 967-970

Himarshi Upadhyay[1], Sahil Patel[2], Rahulkumar Vasava[3], Manisha Vasava[4]

[1]Assistant Professor, Department of General Medicine, GMERS Medical College Vadnagar, Gujarat, India
[2]Assistant Professor, Department of Radiodiagnosis, Nootan Medical College and Research Centre, Visnagar, Gujarat, India
[3]3rd Year Resident, Department of Radiodiagnosis, Gujarat Adani Institute of Medical Sciences, Bhuj, Gujarat, India
[4]Assistant Professor, Department of Radiodiagnosis, Nootan Medical College and Research Centre, Visnagar, Gujarat, India

Abstract

Background: Diagnosing, managing, and treating disorders of the nervous system present distinct challenges owing to the intricate complexities of nervous system. Consequently, these tasks rank among the most demanding responsibilities in healthcare. **Aim and Objectives:** The aim of this study was to assess the precision of Computed Tomography (CT) and Magnetic Resonance Imaging (MRI) scans in the evaluation of neurological disorders. **Materials and Methods:** This retrospective analysis utilized CT or MRI scans for the diagnosis and characterization of brain disorders. Patient records with neurological disorders were included, irrespective of symptom onset, severity, or final clinical diagnosis. Exclusion criteria comprised patients without either CT or MRI scans. Statistical analysis included a chi-square test to evaluate associations between study variables. A total of 234 cases were examined. **Result:** Dyslipidaemia was the most prevalent comorbidity followed by hypertension. Brain disorders were confirmed in 78.21% patients overall, with stroke diagnosed in 48.9% cases. The accuracy rates for CT and MRI were 78% and 74%, respectively. No significant associations were found between imaging modalities, patient characteristics, gender, and disease confirmation. **Conclusion:** Our findings indicate that both CT and MRI exhibit accuracy rates exceeding 75% in detecting neurological disorders, with no discernible disparity between the two techniques.

INTRODUCTION

Neurological disorders affect the nervous system, resulting in various symptoms arising from structural, biochemical, or electrical abnormalities in the brain, spinal cord, or other nerve structures. These disorders present significant challenges within healthcare due to the intricate nature of the nervous system, making diagnosis, management, and treatment particularly demanding. Advances in technology have mitigated some diagnostic challenges in neurology, leading to more dynamic diagnostic capabilities. Extensive literature reviews indicate approximately 600 disorders affecting the nervous system, including Alzheimer's, brain tumors, cerebrovascular diseases, dementia, epilepsy, multiple sclerosis, neuro-infections, Parkinson's disease, stroke, traumatic nervous system injuries.[1-3]

Brain diseases affect individuals globally, irrespective of demographics, with brain cancer being particularly lethal and largely incurable. In the United States, around 1520 cases of brain cancer are reported annually, affecting over 100,000 individuals, with a stable survival rate of 75% over the past decade. Cancer treatment progress has led to increased brain metastasis instances and survival rates, prompting the development of more sensitive diagnostic imaging techniques.[4-6]

The introduction of advanced diagnostic imaging modalities such as CT, Nuclear Medicine (NM), and Magnetic Resonance Imaging (MRI) has significantly benefited neurological evaluation. These technologies, relying on three-dimensional anatomical models, are critical for malignancy diagnosis, treatment planning, and prognosis evaluation. MRI, particularly, aids in cerebrovascular damage assessment and probable diagnosis supplementation. Improved MRI technology enhances understanding of neurobiological alterations, paving the way for novel neuroimaging advancements.[7-9]

MRI is generally preferred over CT due to its superior soft tissue resolution, contrast, reduced artifacts, and multiplanar imaging capabilities, enabling the detection of even the smallest metastases.[4] CT, however, is preferred for stroke diagnosis due to its efficacy, practicality, and sensitivity in detecting Intracranial Haemorrhage (ICH). Past research focused on clinical outcomes like stroke occurrence and mortality, contributing significantly to disease understanding.[10,11]

Prior studies highlighted advancements in CT and MRI for neurological disorders but lacked diagnostic accuracy comparison. Assessing diagnostic accuracy and demographic influences like gender and patient type is crucial. Advancements in diagnostic technology have eased some challenges, yet understanding the underlying causes of disorders and improving survival rates remain imperative. Investigating the impact of diagnostic technologies on patient outcomes is essential, especially considering the severity variation in neurological disorders and the increasing adoption of imaging technologies.[12]

This study aims to evaluate the accuracy of CT and MRI scans in diagnosing neurological disorders, offering insights into neuroimaging and aiding healthcare professionals in selecting optimal imaging techniques for accurate and timely diagnosis.

MATERIALS AND METHODS

In this retrospective investigation, individuals with neurological disorders were scrutinized utilizing CT or MRI imaging modalities. Patients were enrolled irrespective of symptom onset, severity, or final clinical diagnosis; provided they had undergone CT or MRI scans. Patients with MRI contraindications or symptoms indicative of subarachnoid haemorrhage were excluded.

MRI examinations utilized a 1.5 T scanner with enrolled patients undergoing gradient-echo and diffusion-weighted MRI sequences. CT scans were performed using latest scanners. Two experienced neurologists blinded to clinical data, using commercially available software, conducted image analysis. MRI interpretation involved gradient-echo and diffusion-weighted imaging sequences, with the latter including b=0 and T2-weighted images. In cases of motion artifacts rendering gradient-echo images non-interpretable, haemorrhage detection was performed using the b0 component of diffusion-weighted images. For CT interpretation, images optimized for bone and standard brain windows were provided, with brightness and contrast adjustments available.

Data analysis utilized Statistical Package for Social Sciences (SPSS) version 22, examining whether MRI surpasses CT in diagnosing acute strokes. Diagnostic accuracy was assessed against the ultimate clinical diagnosis. Descriptive statistics and the chi-square test were employed, with a significance threshold of $p<0.05$.

RESULTS

A comprehensive analysis encompassed 234 cases. The average age of the participants stood at 45 years, with a standard deviation of 21.4 years, and 107 individuals (45.73%) were females. Predominantly, the patient population consisted of in-patients. Dyslipidaemia emerged as the most prevalent comorbidity, closely followed by hypertension. Radiological imaging confirmed neurological disorders in 78.21% of the patients, as depicted in [Table 1]. Reasons for examination were assessed, indicating that headaches, followed by high blood pressure, were the most commonly reported symptoms. Remarkably, half of the patients, comprising 120 individuals (51.28%), received a diagnosis of stroke.

The precision of the scanning modalities was assessed, with a comparative analysis conducted between CT and MRI. Both modalities demonstrated comparable diagnostic accuracy, as illustrated in [Table 2]. Furthermore, the correlation between patient type and gender was examined concerning the confirmation of brain disorders. However, statistical analysis revealed that these factors were not statistically significant ($p>0.05$), as delineated in [Tables 3 and 4].

Table 1: Study participants' Characteristics

Parameter	**Frequency**	**%**
Gender		
Male	127	54.27
Female	107	45.73
Type of Patient (n=234)		
Casualty	75	32.05
IPD	89	38.03
OPD	70	29.91
Imaging Modality (n=234)		
CT Scan	162	69.23
MRI Scan	72	30.77
Co-morbidity		
Hypertension	45	19.23
Diabetes	55	23.50
Dyslipidemia	60	25.64

ISSN (O): 2687-5365; ISSN (P): 2753-6556

Kidney disorders	13	5.56
Heart Failure	11	4.70
Asthma	17	7.26
COPD	11	4.70
Cancer	5	2.14
Hyperthyroidism	8	3.42
Liver diseases	4	1.71
Alzheimer's disease	3	1.28
Dementia	3	1.28
Seizures	4	1.71
Parkinson's disease	2	0.85
Others	13	5.56
Confirmation of Neurodiagnosis by Radiology		
Yes	183	78.21
No	51	21.79

Table 2: Association of imaging modalities and diagnosis of neurological disorders

Confirmation of Neurodiagnosis by Radiology	Imaging Modality		P Value
	CT Scan (n=162)	MRI Scan (n=72)	
Diagnosis confirmed	125	54	0.25
Diagnosis not confirmed	37	18	
Diagnostic Accuracy	77.16	75.00	

Table 3: Association of type of patient and diagnosis of neurological disorders

Type of Patient	Imaging Modality		P Value
	CT Scan (n=162)	MRI Scan (n=72)	
Casualty			0.36
Diagnosis confirmed	40	17	
Diagnosis not confirmed	12	6	
Total	52	23	
IPD			0.39
Diagnosis confirmed	46	22	
Diagnosis not confirmed	14	7	
Total	60	29	
OPD			0.48
Diagnosis confirmed	39	15	
Diagnosis not confirmed	11	5	
Total	50	20	

Table 4: Association of gender and diagnosis of neurological disorders

Gender	Imaging Modality		P Value
	CT Scan (n=162)	MRI Scan (n=72)	
Female			0.81
Diagnosis confirmed	69	29	
Diagnosis not confirmed	20	9	
Total	89	38	
Male			0.75
Diagnosis confirmed	58	24	
Diagnosis not confirmed	17	8	
Total	75	32	

DISCUSSION

Sophisticated technologies such as Arteriogram, CT scans or CAT scans, Electroencephalography (EEG), Electromyography (EMG), MRI scans, Positron emission tomography (PET scan or PET images), Single photon emission-computed tomography (SPECT) are integral in identifying neurological conditions. These diagnostic tools aid practitioners in confirming or ruling out the presence of neurological disorders or other medical conditions. EEG records brain cell activity through the skull, assisting physicians in detecting and monitoring brain abnormalities associated with various diseases such as epilepsy, degenerative disorders, autism, migraines, specific seizure disorders, sleep disorders, and brain tumors. MRI examinations provide detailed images of bodily structures, including tissues, bones, organs, and nerves, facilitating the identification of brain and spinal cord issues. CT scans utilize X-rays and computer technology to generate cross-sectional images of the body, aiding in the detection of brain abnormalities, strokes, blood clots, tumors, degenerative diseases, and malignancies. Our study focused on evaluating the accuracy of CT and MRI scans in diagnosing neurological disorders.[13-17]

We observed that the majority of patients undergoing examination had experienced a stroke, with headaches and hypertension being the most common reasons for examination. Compared to alternative evaluation methods, neurological examination yielded superior outcomes, consistent with previous research by Holle and Obermann.[1]

However, the literature provides varied assessments regarding the accuracy of CT and MRI. While some studies favour MRI over CT, others suggest both modalities are equally effective in identifying neurological disorders. Although MRI has been recommended as superior in certain studies, our research found no significant difference between CT and MRI in diagnosing neurological issues. This contrasts with findings by Jindal et al,[19] and others, who reported MRI's superiority over CT in diagnosing conditions such as cerebral infarctions and epilepsy. Notably, age did not influence diagnosis in our study.[18-20]

Our findings revealed comparable accuracies of 77.16% for CT and 75% for MRI, consistent with existing literature. Both imaging modalities were deemed adequate for diagnosing primary brain lymphoma, with pathological examinations recommended for confirmation.[21] While some studies advocate MRI's superiority in diagnosing neurological disorders, others call for further research to directly compare CT and MRI.[22] Females were found to be more susceptible to neurological diseases in our study, consistent with previous research findings,[23, 24] and observations of brain functionality differences in chronic migraines by Liu et al.[25]

SPECT scans, though not utilized in our study, play a crucial role in diagnosing malignancies, infections, degenerative spinal diseases, and stress fractures, especially following MRI. Brain SPECT has various applications, including acute ischemia evaluation, stroke assessment, and monitoring treatment effectiveness.[26,27] Limitations of our study include the unavailability of SPECT technology at our institute.

CONCLUSION

Our study found comparable accuracy between CT and MRI for detecting neurological disorders, with no significant difference observed. Diagnosis confirmation across patient types and genders was similar with both modalities. Integration of SPECT alongside CT and MRI is strongly recommended, as it plays a crucial role in screening patients for interventions, aiding in rapid ischemia diagnosis, and identifying at-risk tissue. These findings underscore the importance of multi-modal neuroimaging approaches for enhancing patient outcomes. Further research is warranted to explore specific clinical scenarios and demographic factors influencing diagnostic outcomes.

REFERENCES

1. Holle D, Obermann M. The role of neuroimaging in the diagnosis of headache disorders. Ther Adv Neurol Disord. 2013;6:369-374.
2. Wingerchuk DM, Carter JL. Multiple sclerosis: current and emerging disease-modifying therapies and treatment strategies. Mayo Clin Proceedings. 2014;89:225-240.
3. Siuly S, Zhang Y. Medical big data: neurological diseases diagnosis through medical data analysis. Data Sci Eng. 2016;1:54-64.
4. Weiss D, McLeod-Henning D, Waltke H. Using advanced imaging technologies to enhance autopsy practices. NIJ J. 2018;279:27-33.
5. Gao H, Jiang X. Progress on the diagnosis and evaluation of brain tumors. Cancer Imaging. 2013;13:466.
6. Purandare NC. Inclusion of brain in FDG PET/CT scanning techniques in cancer patients: Does it obviate the need for dedicated brain imaging?. Ind J Nucl Med. 2011;26:64.
7. Meijer FJ, Goraj B, Bloem BR, Esselink RA. Clinical application of brain MRI in the diagnostic work-up of parkinsonism. J Parkinsons Dis. 2017;7:211-217.
8. Weingarten CP, Sundman MH, Hickey P, Chen NK. Neuroimaging of Parkinson’s disease: Expanding views. Neurosci Biobehav Rev. 2015;59:16-52.
9. Seppi K, Poewe W. Brain magnetic resonance imaging techniques in the diagnosis of Parkinsonian syndromes. Neuroimaging Clin. 2010;20:29-55.
10. Völzke H, Schmidt CO, Hegenscheid K, Kühn JP, Bamberg F, Lieb W, et al. Population imaging as a valuable tool for personalized medicine. Clin Pharmacol Ther. 2012;92:422-424.
11. Bamberg F, Kauczor HU, Weckbach S, Schlett CL, Forsting M, Ladd SC, et al. Whole-body MR imaging in the German National Cohort: rationale, design, and technical background. Radiology. 2015;277:206-220.
12. Zhang Q, Li B, Jin S, Liu W, Liu J, Xie S, et al. Comparing the effectiveness of brain structural imaging, resting-state fMRI, and naturalistic fMRI in recognizing social anxiety disorder in children and adolescents. Psychiatry Res Neuroimaging. 2022;323:111485.
13. Yin XX, Hadjiloucas S, Zhang Y, Su MY, Miao Y, Abbott D. Pattern identification of biomedical images with time series: Contrasting THz pulse imaging with DCE-MRIs. Artif Intell Med. 2016;67:1-23.
14. Siuly S, Kabir E, Wang H, Zhang Y. Exploring sampling in the detection of multicategory EEG signals. Comput Math Methods Med. 2015;2015.
15. Yin X, Ng BW, He J, Zhang Y, Abbott D. Accurate image analysis of the retina using Hessian matrix and binarisation of thresholded entropy with application of texture mapping. PLoS One. 2014;9:e95943.
16. Bauer S, Wiest R, Nolte LP, Reyes M. A survey of MRI-based medical image analysis for brain tumor studies. Phys Med Biol. 2013;58:R97.
17. Taleb-Ahmed A, Dubois P, Duquenoy E. Analysis methods of CT-scan images for the characterization of the bone texture: First results. Pattern Recognit Lett. 2003;24:1971-1982.
18. Degnan AJ, Levy LM. Pseudotumor cerebri: a brief review of clinical syndrome and imaging findings. Am J Neuroradiol. 2011;32:1986-1993.
19. Jindal MA, Gaikwad HS, Hasija BD, Vani K. Comparison of neuroimaging by CT and MRI and correlation with neurological presentation in eclampsia. Int J Reprod Contracept Obstet. 2013;2:84.
20. Alam-Eldeen MH, Hasan NM. Assessment of the diagnostic reliability of brain CT and MRI in pediatric epilepsy patients. Egypt J Radiol Nuclear Med. 2015;46:1129-1141.
21. Qin Y, Bao A, Li H, Wang X, Zhang G, Zhu J. Application value of CT and MRI in the diagnosis of primary brain lymphoma. Oncol Lett. 2018;15:8500-8504.
22. Bafaraj SM. Evaluation of neurological disorder using computed tomography and magnetic resonance imaging. J Biosci Med. 2021;9:42.
23. Clayton JA. Sex influences in neurological disorders: case studies and perspectives. Dialogues Clin Neurosci. 2022.
24. Shetewi SG, Al Mutairi BS, Bafaraj SM. The Role of Imaging in Examining Neurological Disorders; Assessing Brain, Stroke, and Neurological Disorders Using CT and MRI Imaging. Adv CT. 2020;9:1-1.
25. Liu J, Qin W, Nan J, Li J, Yuan K, Zhao L, et al. Gender-related differences in the dysfunctional resting networks of migraine sufferers. PLoS One. 2011;6:e27049.
26. Aljahdali S, Azim G, Zabani W, Bafaraj S, Alyami J, Abduljabbar A, SB-Rad. Effectiveness of radiology modalities in diagnosing and characterizing brain disorders. Neurosciences. 2024;29(1):37-43.
27. Camargo EE. Brain SPECT in neurology and psychiatry. J Nucl Med. 2001;42:611-623

ISSN (O): 2687-5365; ISSN (P): 2753-6556