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Indicators Of Neurodegenerative Diseases In Elderly Patients On Routine Mri Brain Using Validated Scoring Systems -A Retrospective Study

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Abstract
Background: Neurodegenerative diseases are a collection of diverse and devastating conditions that can have severe downhill effects on the affected patient and family members. It therefore becomes essential to detect and diagnose them at an early stage. Various validated scoring systems can be used to assess neurodegenerative disease changes on routine MRI scans of the brain.
Aims and objectives:Retrospective analysis of MRI brain studies of elderly patients referred for varied symptomatology(not specific to or pointing towards cognitive impairment) for findings suggesting / indicators pointing towards neurodegenerative diseases using validated scoring systems.
Materials and Methods : 30 elderly patients (both males and females of age 60 years and above) MRI brain studies were analysed and assigned scores / grades according to different scoring systems in different age groups. The results were then studied.
Results :Good number of patients revealed high scores on different scoring systems. This would warrant further dedicated evaluation to diagnose neurodegenerative diseases at an early stage in an otherwise unsuspected clinical scenario . Treatment in such cases can then be initiated accordingly.
Conclusion:Validated scoring systems that can be applied on routinely used MRI sequences can be used to detect / suspect neurodegenerative diseases in an otherwise asymptomatic clinically unsuspected cases.

Keywords: *MRI, Neurodegenerative diseases, Cognitive Impairment, Alzheimers Disease, Dementia scoring systems.*

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I. Introduction

Neurodegenerative diseases are a collection of diverse and devastating conditions that can end up causing significant deterioration of quality of life, increased dependency, considerable distress and sizeable financial burden. The most common of these conditions is Alzheimers Dementia. Non-specific symptoms and difficulty in clinical assessment and detecting the constellation of clinical findings usually results in late diagnosis adding to the agony of the affected patients.[1] Early diagnosis hence helps to initiate treatment thus helping the patient and the family members to cope up with the disease in a better manner.

Dementia is often incorrectly referred to as senility or senile dementia reflecting the widespread but incorrect belief that serious mental decline is a normal part of ageing.

Dementia has been relabelled as major neurocognitive disorder in diagnostic and statistical manual of mental disorders. It is a clinical syndrome that can be defined as progressive deterioration in one or more cognitive functions that is disproportionate to the person's expected functional level at that age.

Neuroimaging plays a crucial and significant role not only in diagnosing reversible causes but also in diagnosing the condition at an early stage, assess disease progression on follow up study and the efficacy of disease modifying treatments.[2]

II. Aims And Objectives

a) To retrospectively analyse the routine MRI studies of elderly patients referred for variable symptomatology (not specific for or pointing to cognitive impairment) for findings/indicators of neurodegenerative diseases.
b) To assess the MRI studies using various scoring systems for severity of the findings indicating neurodegenerative diseases.
c) To identify the pattern and possible etiology of the neurodegenerative disease based on imaging findings and scoring systems.

III. Materials And Methods

All elderly patients (both male and female patients of age 60 years and above) referred to the Department of Radiology of Terna Speciality Hospital and Research centre , Nerul, Navi Mumbai-400706, Maharashtra, India for routine MRI brain for varied symptomatology (not specific for or pointing towards cognitive impairment) were retrospectively analysed. The analysis was done on patients referred rom 01/01/2023 till date. The studies were performed on Siemens 1.5 tesla MRI unit. The sequences assessed for the study were Axial FLAIR, Coronal T1 weighted and Sagittal T1 weighted images

A total of 30 patients (19 males and 11 females) were analysed . The images were assessed for findings indicating the possibility of neurodegenerative disease using the Global cortical atrophy, Medial temporal atrophy, Faseka and Koedam scoring systems. The age groups of both the male and female patients were tabulated followed by assignment of the different scores in each of the age group. All studies showing reversible causes of dementia like subdural collections, Normal pressure Hydrocephalus or intracranial SOL's were excluded from the study.

IV. Results

The tabulated results are as follows-

Table no 1- Age wise distribution of the patients, both males and females.

Age Group in years	Males	Females
60-65	3	1
66-70	5	2
71-75	2	4
76-80	3	1
81-85	5	1
>85	1	2
Total	19	11

Out of 30 patients analyzed 19 were males and 11 were females. The maximum number of male patients were in the age group of 66-70 years and 81-85 years (five patients in each group). The maximum number of female patients were in the age group of 71-75 years (four patients).

Table no 2- Results of different scoring systems in different age groups, both males and females.

Score	60-65y	60-65y	66-70y	66-70y	71-75y	71-75y	76-80y	76-80y	81-85y	81-85y	>85y	>85y
	M	F	M	F	M	F	M	F	M	F	M	F
GCA												
GCA 0	1	1	1	-	-	3	-	-	-	-	-	-
GCA 1	2	-	3	1	2	1	-	1	3	1	-	-
GCA 2	-	-	1	1	-	-	2	-	2	-	1	2
GCA 3	-	-	-	-	-	-	1	-	-	-	-	-
MTA												
MTA0	1	-	2	-	-	-	-	-	-	-	-	-
MTA1	1	-	2	1	-	1	1	-	1	-	-	-
MTA2	-	1	1	1	2	2	1	1	3	-	1	-
MTA3	1	-	-	-	-	1	1	-	-	1	-	1
MTA4	-	-	-	-	-	-	-	-	1	-	-	1
Fazeka												

Fazeka0	1	-	1	-	-	-	-	-	-	-	-	-
Fazeka1	-	1	1	1	2	1	1	-	2	1	-	-
Fazeka2	1	-	1	-	-	2	1	1	2	-	-	-
Fazeka3	1	-	2	1	-	1	1	-	1	-	1	2
Koedam												
Koedam0	1	-	1	-	1	-	-	-	-	-	-	1
Koedam1	2	-	3	2	-	2	-	1	2	1	-	-
Koedam2	-	1	1	-	1	2	2	-	2	-	-	1
Koedam3	-	-	-	-	-	-	1	-	1	-	1	-

Out of 30 patients analyzed, 11 patients (7 males and 4 females) had GCA score of 2 or 3 which implies that these patients merit dedicated evaluation for presence of any cognitive impairment to decide further management accordingly. Two patients (1 male and 1 female) had GCA of 2 in the age group of 66-70 years which is a relatively younger age group as compared to the rest of the 9 patients.

5 patients out of 13 patients in the age group of more than 75 years had MTA score of 3 or more which is abnormal for this age group. 9 patients out of 17 patients in the age group of 75 years or less had a MTA score of 2 or more which is abnormal for this age group.

18 out of 30 patients had a Fazeka's score of 2 or 3 which is considered abnormal or may be normal but with a higher risk of developing disability eventually.

14 out of 30 patients had a Koedam score of 2 or 3 suggesting the possibility of Alzheimer's disease.

V. Discussion

Various neurodegenerative changes are characterized by unique disturbances on histopathological level. Proposed pathophysiological mechanism include the following concepts[3].

- Tauopathies
- Beta amyloid accumulation.
- Alpha synucleinopathies.

Tauopathies are characterized by aggregation of misfolded tau proteins resulting in clumping and destabilisation of microtubules. This causes dissolution and formation of neurofibrillary tangles . Entities such as frontotemporal lobar degeneration and progressive supranuclear palsy fall into this group. Such aggregates have also been noted in chronic traumatic encephalopathy [4](accumulation of 3R and 4R tau aggregates) and Alzheimer's disease (secondary taupathy)[5].

Beta amyloid accumulation is one of the primary observations in Alzheimer's disease. Classically there is extracellular amyloid plaques with intracellular amyloid also playing a role.[6 s]

Abnormal accumulation of alpha synuclein is seen in cases of neurodegenerative diseases with Lewy body inclusion and include Parkinson's disease, Dementia with Lewy bodies and multiple system atrophy.

Cognitive impairment and dementia could be progressive, non progressive and reversible.

Progressive varieties include:
- Alzheimer's disease
- Dementia with lewy bodies
- Frontotemporal lobar dementia
- Vascular dementia
- Parkinson's disease dementia
- Other degenerative dementias like Huntington's disease and chronic traumatic encephalopathy.

Non progressive :
- Traumatic brain injury
- Anoxia
- Vascular (Single stroke)

Reversible:
- Medications like alcohol, sedatives, hypnotics.
- Autoimmune disorders like Multiple Sclerosis, Systemic lupus erythematosis.
- Infections like HIV, Herpes simplex.
- Progressive multifocal leucoencephalopathy.
- Endocrine disorders like Hypothyroidism, Hyperparathyroidism.
- Electrolyte derangement.
- Micronutrient deficiencies.

- Toxin exposures

Scoring Systems on MRI Brain for Dementia

Various validated rating scales are used for evaluation of patients with cognitive impairment on MRI which helps in consistent reporting and also to obtain maximum information from imaging (MRI). [7]Available scoring systems enable systemic evaluation of global atrophy, focal atrophy and for vascular disease (infarcts, white matter lesions and lacunae).The European leukoariosis and disability (LADIS) studies have shown evidences that white matter hypeintensities increase the risk of cognitive decline. [8]

Most of the scoring systems are visual rating scales and can be performed on routine MRI multiplanar imaging studies.Commonly used scoring systems-
GCA scale for global cortical atrophy
MTA scale for medial temporal lobe atrophy
Koedam score for parietal atrophy
Fazekas scale for white matter lesions.

GCA scale

Also known as Pasquier scale is a quantitative rating system whose mean score is used for assessing cortical atrophy throughout the complete cerebrum .
0-No cortical atrophy
1-Mild atrophy : opening of sulci
2-Moderate atrophy: Volume loss of gyri
3-Severe end stage atrophy: 'Knife blade'

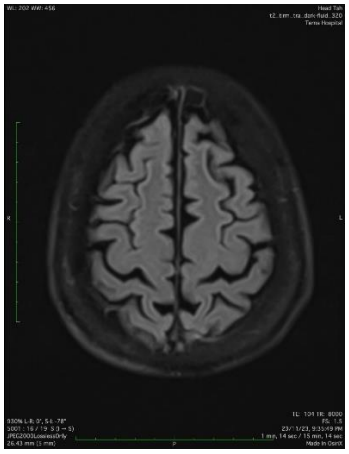

Fig 1: GCA Score 2 Showing Moderate Atrophy In The Form Of Widened Sulci And Volume Loss Of Gyri.

The score is assessed using axial FLAIR images .The atrophy may be asymmetrical or regional. The original Pasquier scale evaluated atrophy in 13 brain regions assessed separately in each hemisphere with a final score that is the sum of all regions. [9]Following the original publication other studies have proposed simplification of Pasquier scale to provide a more general impression of atrophy throughout the brain making it easier and more acceptable. [10]

Moderate to severe GCA can occur in patients of Alzheimer's disease or cerebrovascular disease. This should always be kept in mind during evaluation of clinical and imaging findings during the workup of patients with cognitive complaints. It should also be remembered that moderate to severe GCA need not be entirely due to age related atrophy. [11]

MTA score

Scoring is done on coronal TIWI with slice position through corpus of hippocampus at the level of anterior pons.[12] Score is based on visual rating of width of choroid fissure, width of temporal horn and height of hippocampus formation.

Score:
0-No atrophy.
1-Only widening of choroid fissure.
2-Also widening of temporal horn of lateral ventricle.

3-Moderate loss of hippocampus volume (decrease in height).
4-Severe volume loss of hippocampus.

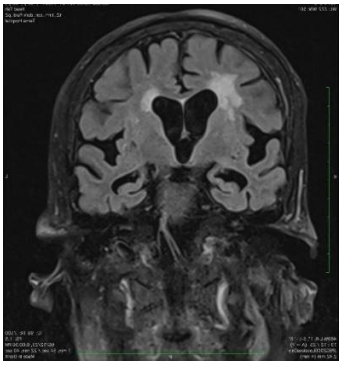

Fig 2: MTA Score 3 On Coronal Image Showing Widening Of Choroidal Fissure, Dilatation Of Temporal Horn Of Lateral Ventricle And Hippocampal Atrophy.

MTA score is also known as Schelten's scale and is useful in distinguishing patients with mild cognitive impairment and Alzheimer's disease from those without impairment. [13] MTA score of 2 or more is abnormal for less than 75yrs. MTA score of 3 or more is abnormal for more than 75 years.

MTA score is a good test to discern controls from patients with Alzheimer's disease .Test is however not completely specific for AD and can also be seen in other forms of dementia like FTLD, vascular dementia and dementia with Lewy bodies. [14] MTA score has a sensitivity of 75% and specificity of 85% to discriminate Alzheimer's disease from healthy controls. [15]

MTA score however does not take into consideration atrophy of entorhinal cortex which has been shown to occur early in the development of Alzheimer's disease.

Koedam Score

It is score of parietal atrophy which has a positive predictive value in diagnosis of AD. Atrophy of precuneus in particular is characteristic of AD.[16] Koedam scale rates parietal atrophy assessed in sagittal, coronal and axial planes for widening of posterior cingulate and parieto-occipital sulci. When different scores are obtained in different orientation, the highest score is considered. [17]

Grade0- Closed sulci, no gyral atrophy
Grade1- Mild sulcal widening, mild gyral atrophy
Grade2- Substantial sulcal widening, substantial gyral atrophy
Grade3- Marked sulcal widening, knife blade gyral atrophy

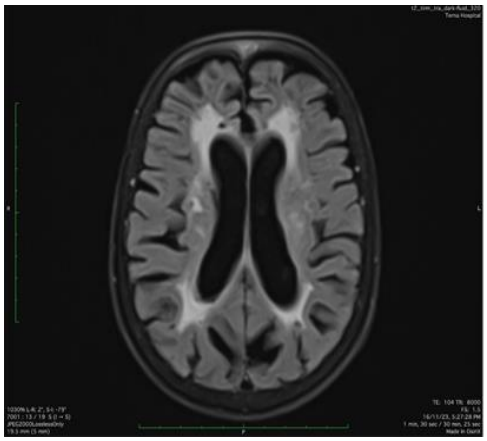

Fig 3: Koedam's Grade 3 On Axial FLAIR Image Showing Significant Widening Of The Parieto Occipital Sulcus.

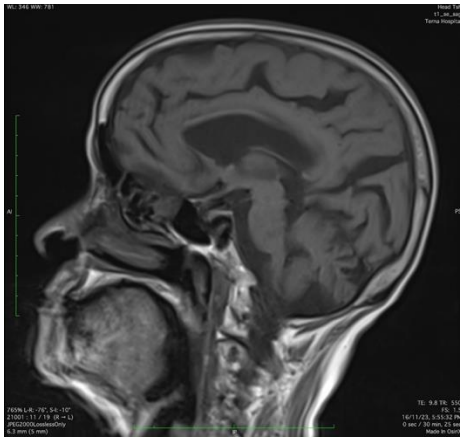

Fig 4: Koedam Grade 3 On Sagittal T1WI Showing Significant Widening Of The Cingulate And Parieto Occipital Sulcus.

Koedam score is useful in assessment of patients with possible dementia, especially atypical or early onset Alzheimer's disease. In patients with amyloid positive mild cognitive impairnment, parietal atrophy could predict progression to dementia independently of median temporal atrophy. [18]

Fazeka's scale

It provides an overall impression of the presence of white matter hyperintensities in the entire brain (both periventricular and deep white matter). Deep white matter component score is useful in assessment of patients with dementia or for neurodegenerative diseases. This score is best assessed on transverse/ axial FLAIR or T2WI.

Score
0-None or single punctate white matter lesions
1-Multiple punctate lesions
2-Beginning confluency of lesions (bridging)
3-Large confluent lesion

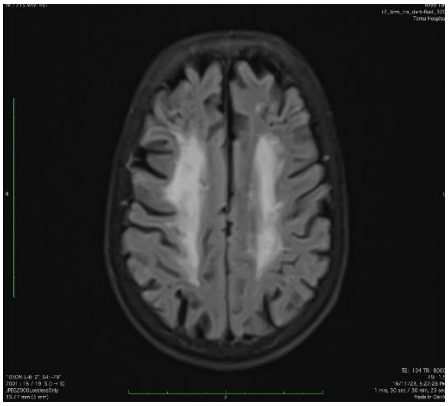

Fig 5: Fazeka Score 3 – Axial FLAIR Image Showing Large Confluent Bilateral Deep White Matter Hyperintensities.

Fazeka 1 is considered normal in elderly. Fazeka 2 and 3 are pathologic but may be seen in normal functioning individuals, however they are at high risk of disability.

Inzitari D et al [19] have concluded in their 3 year follow up studies that severe white matter changes independently and strongly predict rapid global functioning decline.

Tae Won Kim et al [20] in their retrospective cross sectional study found out that impairment of cognitive function with infratentoral stroke appeared to be associated with white matter hyperintensities.

VI. Conclusion

Validated scoring systems can be applied to routinely used MRI sequences to detect / suspect neurodegenerative diseases . These scoring systems sometimes also help in assessing the severity of the disease and also in narrowing down the differential diagnosis. Advocating regular application of these scoring systems

on routine MRI brain sequences as a protocol during reporting would help in early detection of neurodegenerative diseases in otherwise asymptomatic and clinically unsuspected cases.

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