# Radiographic Findings in the Geriatric and Cognitively Impaired Brain. What do Clinicians Look For?

Dr Salam Findakly[1]
1. Monash Health, Australia

## Introduction

Radiographic imaging of the brain is one of the most common investigations requested by clinicians.

Computed Tomography (CT) of the brain is a quick and easily accessible resource that can provide clinicians with useful information to determine the underlying aetiology of a patient's presentation. It is useful for looking at acute pathologies, such as intracranial haemorrhages or ischaemic events, mass effects from space occupying lesions that can distort normal brain anatomy, as well as other anatomical changes from various neurodegenerative conditions. Clinical information is imperative for a radiologist to accurately assist a clinician in making a diagnosis.

Magnetic Resonance Imaging (MRI) provides further detailed information of brain anatomy and underlying pathology, however, it is a more expensive test and is less readily available.

This article looks at the various age related neurological changes seen on radiographic imaging of the brain in the geriatric population, with a focus on CT imaging of the brain, as well as other clues to help diagnose underlying neurodegenerative disorders. While the majority of neurodegenerative disorders are clinically diagnosed, imaging can often help support this clinical diagnosis and rule out other differentials.

## Background

A random retrospective audit of CT brain reports on a geriatric subacute ward over a 3-month period (between October 2018 and January 2019) was conducted. There were 90 patients admitted to the unit, 42 patients (46.7%) had a CT brain requested at some point during their hospital admission. 13 (30.9%) of the requests were made by the subacute team and 34 (80.9%) were made by the acute team. 5 patients (5.6%) had a CT Brain during both their acute and subacute admissions. 28 (66.7%) of the reports commented on generalised atrophy, while 5 (11.9%) reports commented on specific regions of atrophy in the brain. All 5 of the CT brain reports that commented on specific regions of atrophy contained the phrases 'cognitive decline' or 'confusion' in the clinical history. The most common primary indications for a CT brain were falls (19, 40.4%), symptoms of stroke (8, 17%), confusion (6, 12.8%), delirium (3, 6.4%) and fluctuating or drop in GCS (3, 6.4%).

## Normal Age Related Changes

The brain, like many other tissues in the body, experiences atrophy with age, also known as involutional changes. It experiences change not only in structure, but also function and metabolism. It is believed that the brain volume and weight decreases with age by approximately 5% per decade after the age of 40, with a quicker decline after the age of 70.[1] Gender may also play a role, with men often experiencing an earlier onset of atrophy, however, women experiencing a quicker rate of change once atrophy begins.[2] Atrophy is seen as both the loss of brain tissue volume, as well and the widening of the sulci between adjacent gyri.

Previous studies that have monitored patients over a period of time and assessed their anatomy with MRI, have shown that the greatest brain regions that atrophy with age, other than the total brain volume, are the prefrontal cortex, temporal lobes and hippocampi.[3] Men and women may also differ, with frontal and temporal lobes most affected in men compared with the hippocampi and parietal lobes in women.[4]

There is an increase in the degree and number of micro-vessel deformities, also known as small vessel ischemia (figure 1), every decade of life after the age of 50.[5] Furthermore there is a greater loss of white matter than grey matter.

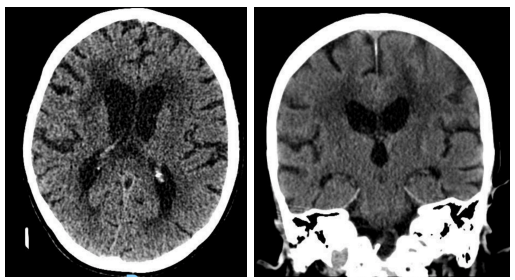
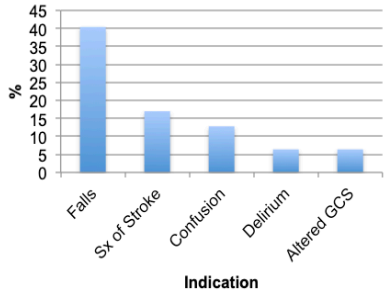
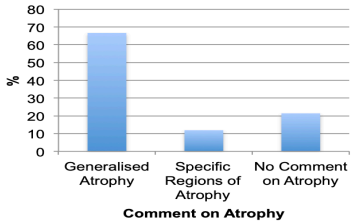


***Figure 1**: Non-contrast axial and coronal CT Brain slices of a 90yo female presenting with an acute delirium. Neuroimaging showing appropriate age related involutional atrophy and periventricular hypoattentuation consistent with chronic small vessel ischaemia. Notice the relative sparring of the hippocampi.*

## Indications for CT Brain




## Radiology Report Comments




## Defining Cognitive Impairment

The new Diagnostic and Statistical Manual of Mental Disorders 5 (DSM-5) classification of cognitive impairment differentiates the various stages of impairment.[14]

Major neurocognitive disorder (NCD) is the new term used to describe dementia, while minor NCD is now used to describe mild cognitive impairment (MCI), however the terms are still interchangeable. The new classification focuses more on decline rather than deficit.

The 6 cognitive domains that are assessed are complex attention, executive function, learning and memory, language, perceptual-motor function, and social cognition.

Minor NCD is the evidence of modest decline from previous function, but the affected individual can still maintain independence, while major NCD is a more significant decline and the loss of independence.[14] The next step for a clinician is to determine the underlying subtype of cognitive decline.

## Vascular Dementia

Vascular dementia is cognitive impairment that me be secondary to multiple white matter lesions, cortical, lacunar, or subcortical infarcts, and cerebral micro-haemorrhages.

The prevalence and severity of these changes increase with age as vascular damage becomes more likely to occur and contributes to cognitive decline and dementia.[12] The risk factors that help a clinician consider vascular dementia are hypertension, dyslipidaemia, diabetes mellitus, smoking, and a history of ischaemic heart disease or stroke.

Both CT and MRI can detected these vascular lesions, however, MRI is much more sensitive.

## Alzheimer's Dementia

Alzheimer's Dementia (AD) is a progressive neurodegenerative disorder and the most common cause of dementia, accounting for approximately two-thirds of all cases.[13] It is caused by an accumulation and deposition of cerebral amyloid-B.

There are 3 phases of the disease, pre-clinical AD, where there is disease in the brain but no clinical features, MCI due to AD, and dementia caused by AD.

CT imaging of the brain can be used to aid the clinical diagnosis of AD, by providing radiographic clues of the characteristic patterns of cerebral change to support the diagnosis.

The major finding of neurodegenerative conditions such as AD is cerebral atrophy, with a more advanced degree of atrophy than that seen in normal age related changes. The entorhinal cortex (located within the medial temporal horn) is typically the earliest site of atrophy, closely followed by the hippocampus, amygdala, and parahippocampus (figure 2).[6] The main cause of atrophy is believed to be neuronal and dendritic losses. Radiographic volume loss has been shown to be closely related to neuronal counts at autopsy.[7]

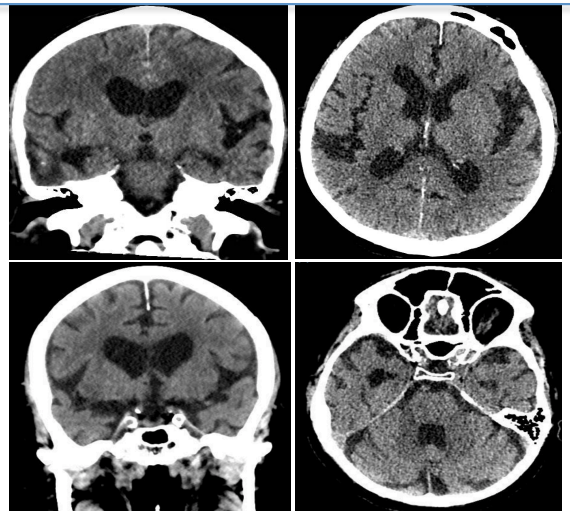


***Figure 2**: Non-contrast coronal and axial CT Brain slices of an 83yo male presenting with features of advanced dementia. Notice the marked hippocampal atrophy (top left), medial temporal lobe atrophy (bottom right), with prominent Sylvian fissures (top right) and para-hippocampal gyral atrophy (bottom left), all characteristic features of Alzheimer's dementia.*

## References

***1.** Peters R. Ageing and the brain. Postgrad Med J 2006;82:84–88. doi: 10.1136/pgmj.2005.036665*
***2.** Small SA. Age-related memory decline: current concepts and future directions. Archives of neurology. 2001;58:3604*
***3.** Scahill R, Frost C, Jenkins R. et al. A longitudinal study of brain volume changes in normal ageing using serial registered magnetic resonance imaging. Arch Neurol 20036989–994.*
***4.** Murphy D, DeCarli C, McIntosh A. et al Sex differences in human brain morphometry and metabolism: an in vivo quantitative magnetic resonance imaging and positron emission tomography study on the effect of ageing. Arch Gen Psychiatry 199653585–594*
***5.** Trollor JN, Valenzuela MJ et al. Brain ageing in the new millennium. The Australian and New Zealand journal of psychiatry. 2001;35:788–805*
***6.** Killiany RJ, Hyman BT, Gomez-Isla T. MRI measures of entorhinal cortex vs hippocampus in preclinical AD. Neurology. 2002 Apr 23; 58(8):1188-96*
***7.** Jack CR Jr, Dickson DW, Parisi JE et al. Antemortem MRI findings correlate with hippocampal neuropathology in typical aging and dementia. Neurology. 2002 Mar 12; 58(5):750-7*
***8.** Duara R, Loewenstein DA, Potter E et al. Medial temporal lobe atrophy on MRI scans and the diagnosis of Alzheimer disease. Neurology. 2008 Dec 9; 71(24):1986-92*
***9.** Hurley RA, Bradley WG, Latifi HT et-al. Normal pressure hydrocephalus: significance of MRI in a potentially treatable dementia. J Neuropsychiatry Clin Neurosci. 1999;11 (3): 297-300.*
***10.** Norfray JF, Provenzale JM. Alzheimer's disease: neuropathologic findings and recent advances in imaging. AJR Am J Roentgenol. 2004;182 (1): 3-13.*
***11.** Whitwell JL, Weigand SD, Shiung MM et-al. Focal atrophy in dementia with Lewy bodies on MRI: a distinct pattern from Alzheimer's disease. Brain. 2007;130 (Pt): 708-19.*
***12.** Prins ND, Scheltens P. White matter hyperintensities, cognitive impairment and dementia: an update. (2015) Nature reviews. Neurology*
***13.** Jessica J. Jalbert Lori A. Daiello Kate L. Lapane. Dementia of the Alzheimer Type. Epidemiologic Reviews, Volume 30, Issue 1, 1 November 2008, Pages 15–34*
***14.** American Psychiatric Association. (2013). Diagnostic and statistical manual of mental disorders (5th ed.). Arlington, VA: American Psychiatric Publishing*

## Lewy Body Dementia

Lewy body dementia (LBD) is the second most common type of dementia. It is caused by the deposition of proteins, known as Lewy bodies, in the neuronal cells of the brain.

In addition to mild or major NCD that the disease may cause, patients may also experience visual hallucinations, movement disorders similar to Parkinsonism, sleeping difficulties, and autonomic nervous system dysfunction.

LBD is distinguished from dementia secondary to Parkinson's Disease in that the cognitive impairment precedes the physical symptoms of Parkinson's.

Neuroimaging in the form of CT and MRI brain scans are limited in their use. There has been no reliable pattern of anatomical change is distinguish LBD from other neurodegenerative diseases. However, some literature suggests a pattern of atrophy that may be more focused in the midbrain, hypothalamus and substantia innominata, with a relative sparing of the hippocampus and temporoparietal cortex compared with AD patients.[11] The lateral ventricles may also be more enlarged.

## Normal Pressure Hydrocephalus

Normal pressure hydrocephalus (NPH), which is the accumulation of CSF fluid in the brain's ventricles, presents with the triad of cognitive impairment, gait ataxia, and urinary incontinence, however, not all these symptoms may be present. It can therefore be a differential diagnosis of cognitive impairment that may be mistaken for dementia.

Neuroimaging assists with diagnosis by assessing the brains anatomy. CT imaging is useful but MRI can provide even greater anatomy characterisation. Typical findings are ventriculomegaly (figure 3) and changes in the sulci anatomy, such as sulci crowding at the vertex, a dilated Sylvian fissure, and the posterior portion of the cingulate sulcus being narrower than the anterior portion.[9] Ultimately, a lumbar puncture tap test is the gold standard for diagnosis

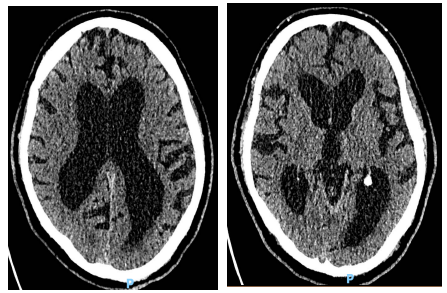


***Figure 3**: Axial slices of a non-contrast CT Brain of an 82yo male, presenting with the triad of cognitive decline, gait ataxia, and urinary incontinence and frequency. The images show enlarged ventricles (ventriculomegaly), which is out of proportion to cerebral atrophy present.*

## Conclusion

While predominantly a tool used to rule out acute intracranial pathology, as evident in the above audit, with more than half (57.4%) of CT brain requests being made secondary to falls or stroke-like symptoms, a radiology report assessing the brain's anatomy and commenting on specific changes can greatly assist a clinician in diagnosing underlying neurodegenerative disorders.