Canadian Consensus on Dementia
Neuroimaging Section – Computed tomography of the brain

The Third Canadian Consensus Conference on Diagnosis and Treatment of Dementia offered two recommendations for structural imaging pertaining to the general clinical setting. [1] These partially exclusionary recommendations were supporting on the one hand the selective use of neuroimaging imaging procedures based on the first canadian consensus on dementia of 1989,[2] and on the other hand, for the first time supporting the use of routine imaging to rule-in asymptomatic cerebrovascular disease. No specific choice of imaging modality was recommended. Here we review briefly recent evidence pertaining to the use of CT scans in the assessment of dementia, with a focused review of pertinent MRI data.

The use of CT scan in dementia assessment is still prevalent in Canada. Availability of MRI varies greatly across different areas. According to a CIHI report, by January 1, 2011, there were 293 MRI scanners and 508 CT scanners operational in Canada. (http://www.cihi.ca/ accessed April 2012)

A Pubmed search with the terms CT scan and dementia yields only 260 articles published since 2007, when the last Canadian Consensus was published; in contrast, there are more than 10 times as many published papers using MRI in dementia.
Although brain MRI has been a very active research topic in dementia research in recent years, not a single one of the sophisticated techniques has been applied clinically until now. The structural imaging measure supported by the most evidence is hippocampal atrophy (HA). This measure can be estimated either with complex volumetric MRI techniques, or with simple visual rating scales, with equivalent likelihood ratios. [3]. Hippocampal atrophy has been incorporated in both the Dubois Criteria ad the new NIA Criteria for AD. [4, 5]
However, this putative diagnostic test has not been adopted widely in clinical settings ; one the main limitations of evidence on HV is that almost all studies are from referral cognitive disorders clinics, and the usefulness of HV in more general settings has not been established.[3]
It remains to be seen if the new AD criteria which includes MRI-defined hippocampal atrophy will be adopted in clinical practice. This could be a driver of increased MRI use in clinical practice. However, automated methods for brain volumetry necessitates high quality images and highly skilled technicians, in addition to computer science support that is not readily available in clinical settings. Constraints of time, costs and human resources limit the applicability of the advances in research MRI.
On a more philosophical note, one could make the argument that since there is a great discrepancy between our relatively great ability to diagnose AD early and our relative lack of therapeutic effectiveness to prevent cognitive decline, efforts to incorporate biomarkers to clinical diagnosis are premature.

If hippocampal volume has been the mainstay of volumetric MRI in AD, diagnostic discrimination of AD has become almost 100% in some research reports using whole brain volumetric analysis. [6] These technique have yet to be standardized and simplified in order to be useful clinically, similar to HV.

Despite the tremendous effort in MRI research, there were still a few important papers that were published since 2007 on the use of CT in dementia. Traditional, older CT scans lacked the spatial resuolution necessary to detect brain atrophy or white matter changes with a similar sensitivity to MRI. However the newer more powerful scanners appear to perform much better than older generations of scanners. The brief discussion of MRI volumetric measurements above was necessary in the light of an important paper that re-assessed the performance of latest–generation CT scans against MRI. This report compared the value of the most recent CT-scan technology, the 64 detector row computed CT to 1.5 T MRI in the visual rating of hippocampal on coronal images, cortical atrophy on axial images and the assessment of age-related white matter changes using a visual rating scale. [7] In this report, visual analysis on CT scans was comparable to that obtained on matched brain MRI. In addition, the detection of white matter changes (leucoaraiosis) was also comparable between the two imaging modalites. This might come as a surprise to most practicing clinicians. The detection of clinically meaningful WMC, hippocampal and cortical atrophy with CT scans in a way « re-habilitates » this old brain imaging technique as a pertinent tool to asses dementia in 2012. There was no systematic difference between CT and MRI ratings in any of the scales that were used in this cohort from a Memory Clinic, including for the estimation of hippocampal atrophy. Thus there is now documentation of the non-inferiority the latest CT scanners compared to MRI for the routine work-up of dementia.

Another report confirmed earlier studies on the usefulness of simple linear measures on CT in the discrimination between AD and elderly controls. [8] The multiple measures are simpler to apply than volumetric measures on MRI, but do not show the same discriminative ability than MRI measures.

A recent review (2011) acknowledged the enduring role of CT scan in the clinical diagnosis of dementia, with several advantages over MRI. [9] Lower cost, shorter duration, increased availability, ability to image patients with metallic devices such as pace-makers, or those who suffer from claustrophobia. Its ability to exclude potentially reversible causes of dementia is also a frequent justification to use it.
The 1989 Canadian Consensus criteria [2] to order a brain imaging procedure would miss few of the potentially reversible conditions in a memory clinic setting, [10] but such clinical decision rules have been shown to have a limited ability to predict accurately the actual absence of a reversible condition. Indeed, sensititivity of these rules in general is insufficient to detect all reversible conditons. [11] It must be stressed that the context in which these criteria have been formulated was one where CT scanners were few and far between across Canada. Nowadays, the situation has changed dramatically, with much better acces in most regions of the country (more than 500 scanners were operating in Canada in 2010 ; in Québec there are 64 high-resolution CT scanners in operation).

Finally, another important factor that is usually not discussed is the stark contrast between the values of social justice and allocation of resources, with the goal of reducing the rate of neuroimaging for patients with dementia in our health system, and the individual benefits to patients and their families of investigating the cognitive symptoms in a thorough manner. This subjective benefit has not been assessed formally to our knowledge, but clinical

experience suggests that patients with cognitive disorders expect some kind of brain imaging when they seek medical attention.

Recommendations :
1- The inclusion of structural imaging (CT or MRI) as a routine test as per the 2007 criteria is maintained and reinforced : structural imaging should be used routinely « to rule in cerebrovascular disease ».
2- Visual estimation of hippocampal atrophy on coronal images or CT or MRI is useful to support a diagosis of AD in the context of a specialty referral clinic.
3- The context in which the CCAD criteria to withhold brain imaging were developed has changed significantly to the point where they are no longer pertinent. All individuals with dementia should benefit from at least one structural imaging procedure.

References

1. Chow T. Structural neuroimaging in the diagnosis of dementia. Alzheimers Dement 2007;3:333-335.
2. Organizing Committee CCCotAoD. Assessing Dementia: the Canadian Consensus. Cmaj 1991;144:851-853.
3. Wahlund LO, Almkvist O, Blennow K, et al. Evidence-based evaluation of magnetic resonance imaging as a diagnostic tool in dementia workup. Top Magn Reson Imaging 2005;16:427-437.
4. Dubois B, Feldman HH, Jacova C, et al. Research criteria for the diagnosis of Alzheimer's disease: revising the NINCDS-ADRDA criteria. Lancet Neurol 2007;6:734-746.
5. McKhann GM, Knopman DS, Chertkow H, et al. The diagnosis of dementia due to Alzheimer's disease: recommendations from the National Institute on Aging-Alzheimer's Association workgroups on diagnostic guidelines for Alzheimer's disease. Alzheimers Dement 2011;7:263-269.
6. Fan Y, Resnick SM, Wu X, Davatzikos C. Structural and functional biomarkers of prodromal Alzheimer's disease: a high-dimensional pattern classification study. Neuroimage 2008;41:277-285.
7. Wattjes MP, Henneman WJ, van der Flier WM, et al. Diagnostic imaging of patients in a memory clinic: comparison of MR imaging and 64-detector row CT. Radiology 2009;253:174-183.
8. Zhang Y, Londos E, Minthon L, et al. Usefulness of computed tomography linear measurements in diagnosing Alzheimer's disease. Acta Radiol 2008;49:91-97.
9. Pasi M, Poggesi A, Pantoni L. The use of CT in dementia. Int Psychogeriatr 2011;23 Suppl 2:S6-12.
10. Freter S, Bergman H, Gold S, Chertkow H, Clarfield AM. Prevalence of potentially reversible dementias and actual reversibility in a memory clinic cohort. Cmaj 1998;159:657-662.
11. Gifford DR, Holloway RG, Vickrey BG. Systematic review of clinical prediction rules for neuroimaging in the evaluation of dementia. Arch Intern Med 2000;160:2855-2862.