Medial temporal lobe atrophy and white matter hyperintensities are associated with mild cognitive deficits in non-disabled elderly people: the LADIS study

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Objective: To assess the associations of medial temporal lobe atrophy (MTA) and white matter hyperintensities (WMH) with cognitive function in a large group of independently functioning elderly people.

Methods: Data were drawn from the multicentre, multinational leukoaraiosis and disability (LADIS) project which is studying prospectively the role of WMH as an independent predictor of the transition to disability in non-disabled elderly people. In all, 639 participants were enrolled in the LADIS study. For the present analysis, data on 581 subjects were available. Cognitive function was assessed by the mini-mental state examination (MMSE). Visual ratings of WMH and MTA were undertaken on magnetic resonance images (MRI).

Results: The presence of either severe WMH or MTA was associated with a modest but non-significant increase in frequency of mild cognitive deficits (severe WMH: odds ratio (OR) = 1.9 (95% confidence interval (CI), 1.0 to 3.7); MTA present: OR = 1.5 (95% CI, 0.8 to 2.8)). However, subjects with the combination of MTA and severe WMH had a more than fourfold increase in frequency of mild cognitive deficits (OR = 4.1 (95% CI, 2.3 to 7.4)). Analysis of variance with post hoc Bonferroni tests showed that subjects with both MTA and severe WMH performed worse on MMSE than those with either no MRI abnormality or a single MRI abnormality (p < 0.05).

Conclusions: These results provide further evidence for the combined involvement of both Alzheimer type pathology and vascular pathology in the earliest stages of cognitive decline and suggest an additive effect of WMH and MTA.

Methods: Data were drawn from the multicentre and multinational leukoaraiosis and disability (LADIS) project which is studying prospectively the role of WMH as an independent predictor of the transition to disability in non-disabled elderly people. The design of the LADIS project has been fully described elsewhere. In short, 639 elderly subjects who had no or only mild disability in their instrumental activities of daily living (IADL) and who were stratified for WMH severity were enrolled between 18 July 2001 and 31 January 2003. Subjects presented with complaints including mild cognitive or motor disturbances, minor cerebral events, mood alterations, other neurological problems, or in whom WMH were incidentally identified on brain imaging. Subjects participating as controls in other studies and volunteers were also included. To be included, subjects had to meet the following criteria:

- age between 65 and 84 years;
- WMH on MRI of any degree, according to the categorisation into the three severity classes of a revised version of the Fazekas scale;
- no or only mild disability as determined by the IADL scale;
- presence of a regularly contactable informant;
- agreement to sign informed consent.

Exclusion criteria were: the likelihood of dropping out because of the presence of severe illnesses (cardiac, hepatic, or renal failure, cancer, or other relevant systemic diseases); severe unrelated neurological diseases; leucoencephalopathy of non-vascular origin (immunological-demyelinating, metabolic, toxic, infectious, other); severe psychiatric disorders;

Abbreviations: IADL, instrumental activities of daily living; LADIS, leukoaraiosis and disability project; MMSE, mini-mental state examination; MTA, medial temporal lobe atrophy; WMH, white matter hyperintensities.
inability to give informed consent; and inability or refusal to undergo cerebral MRI. Subjects are currently followed up for three years with repeated clinical and MRI studies. The present paper is based on the baseline data of the LADIS project.

All subjects were assessed using an extensive set of clinical and functional tests including global functioning, and cognitive, motor, psychiatric, and quality of life measures. For the present study, general cognitive function was assessed by the mini-mental state examination (MMSE).10 Subjects with an MMSE score of 26 or more were considered to have “good cognitive function,” whereas those with an MMSE score below 26 were considered to have “mild cognitive deficit.”

There were 581 subjects (54% female). Their mean (SD) age was 74 (5) years; their years of education, 10 (4); and their MMSE score, 27 (2). The majority of subjects had good cognitive function (n = 486, defined as MMSE score, 27 (2). There were 95 subjects with mild cognitive deficits (MMSE score below 26). There were 95 subjects with mild cognitive deficits (MMSE <26). There was a predominance of women among the subjects with an MMSE score below 26 (x^2 = 3.8, p = 0.05), and they had received less education (t = 7.1, p<0.001).

### RESULTS

There were 581 subjects (54% female). Their mean (SD) age was 74 (5) years; their years of education, 10 (4); and their MMSE score, 27 (2). The majority of subjects had good cognitive function (n = 486, defined as MMSE ≥26), but there were 95 subjects with mild cognitive deficits (MMSE <26). There was a predominance of women among the subjects with an MMSE score below 26 (x^2 = 3.8, p = 0.05), and they had received less education (t = 7.1, p<0.001).

**Table 1** Odds ratios for mild cognitive deficits dependent on medial temporal lobe atrophy and white matter hyperintensities

<table>
<thead>
<tr>
<th>Medial temporal lobe atrophy</th>
<th>Absent</th>
<th>Absent</th>
<th>Present</th>
<th>Present</th>
</tr>
</thead>
<tbody>
<tr>
<td>White matter hyperintensities</td>
<td>Mild</td>
<td>Severe</td>
<td>Mild</td>
<td>Severe</td>
</tr>
<tr>
<td>Good cognitive function (n)</td>
<td>302</td>
<td>56</td>
<td>82</td>
<td>46</td>
</tr>
<tr>
<td>Mild cognitive deficits (n)</td>
<td>40</td>
<td>14</td>
<td>16</td>
<td>25</td>
</tr>
<tr>
<td>Crude odds ratio (95% CI)</td>
<td>1.0 (reference)</td>
<td>1.9 (1.0 to 3.7)</td>
<td>1.5 (0.8 to 2.8)</td>
<td>4.1 (2.3 to 7.4)</td>
</tr>
<tr>
<td>Adjusted odds ratio (95% CI)</td>
<td>1.0 (reference)</td>
<td>1.8 (0.9 to 3.9)</td>
<td>1.4 (0.7 to 2.8)</td>
<td>4.6 (2.3 to 9.0)</td>
</tr>
</tbody>
</table>

Data are presented as odds ratios and their 95% confidence intervals (CI). Adjusted odds ratios are corrected for age, sex, education, and presence of stroke and/or lacunes. MMSE, mini-mental state examination; MTA, medial temporal lobe atrophy; WMH, white matter hyperintensities.

There was a significant correlation between the presence of severe WMH and MTA (Spearman’s r = 0.27, p<0.001). The presence of either severe WMH or MTA was associated with a modest but non-significant increase in frequency of mild cognitive deficits (severe WMH, p = 0.06; MTA present, p = 0.23, see table 1). However, subjects with the combination of MTA and severe WMH had a more than fourfold increase in the frequency of mild cognitive deficits (p<0.001). These risk estimates did not change essentially when age, sex, education, and the presence of stroke or lacunes were entered as covariates. Formal testing in a logistic regression model incorporating the interaction term between MTA and WMH showed that there was no statistical interaction between MTA and WMH.

Figure 1 Mean mini-mental state examination (MMSE) score according to the presence of medial temporal lobe atrophy (MTA) and age related white matter hyperintensities (WMH). The group with both MTA and severe WMH had a lower MMSE score than the groups with a single MRI abnormality or no abnormality (p<0.05).

DISCUSSION

We showed that a combination of MTA and severe WMH was associated with a more than fourfold increase in the frequency of mild cognitive deficits in a large group of non-disabled elderly people. By contrast, mild cognitive deficits were not more frequent in the groups of patients with a single MRI abnormality (either MTA or severe WMH). These results suggest the combined involvement of both Alzheimer type pathology and vascular pathology in the earliest stages of cognitive decline.
Medial temporal lobe atrophy and white matter hyperintensities

Former studies (both necropsy and MRI) reported that Alzheimer type pathology and vascular pathology often coexist in patients with dementia.1–26 The present study extends these findings, as we observed in vivo using MRI that even in non-disabled elderly people the combination of MTA and WMH was already associated with decreased cognitive performance. These findings provide further evidence for the threshold theory, which stipulates that Alzheimer type pathology and cerebrovascular pathology summate until a threshold is reached and clinical dementia ensues.27

In seeming contrast to earlier studies,1–1215 the presence of MTA alone was not significantly associated with cognitive impairment. The specific characteristics of the LADIS study sample probably account for this finding. Subjects were included on the basis that they had WMH on MRI in combination with absence of disability, resulting in a study population that is biased towards excessive vascular pathology and relatively little Alzheimer type pathology. However, even in this population, where cognitive impairment would be expected to be of vascular origin, the association between WMH and cognitive impairment could only be fully appreciated if MTA was also taken into account.

A possible limitation of this study includes the use of dichotomised rather than continuous measures of MTA and WMH. In addition, we used the MMSE, which is a rather crude measure of cognitive function. It is conceivable that the use of continuous MRI variables and a more sensitive cognitive test would have yielded more striking results. However, we feel that our simple approach enhances the clinical value of our results, as the MMSE is one of the most widely used cognitive tests. In addition, contrasting with sophisticated, but time intensive neuromaging measures, simple ratings of MTA and WMH can be used in clinical practice.

These results may have important clinical implications. Memory clinics often evaluate patients who present with subjective memory complaints and severe WMH on MRI, but who have no detectable cognitive deficits. The present study suggests that if such patients have additional MTA they may be at increased risk of subtle cognitive impairment. Should further studies using a longitudinal design corroborate our finding that the combination of WMH and MTA is indeed predictive of subsequent cognitive decline, the combination of these simple MRI markers may be a useful tool in identifying subjects at risk of dementia. Whether this combination of markers predicts dementia at follow up in the present sample will be the subject of further study.

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The LADIS Steering Committee is formed by Domenico Inzitari MD (study coordinator), Timo Erkinjuntti MD, PhD, Philip Scheltens MD, PhD, Marieke Visser MD, PhD, and Björn Eriksson MD, PhD.

REFERENCES


APPENDIX

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Competing interests: Philip Scheltens is an associate editor of JNNP but had no role in reviewing or accepting this paper.
Hemifacial spasm, neuralgia, and syncope due to cranial nerve compression in a patient with vertebral artery ectasia

A 42 year old woman with a history of an incompletely remitted peripheral left facial nerve palsy that was followed by clusters of hemifacial spasm and paroxysms of lancinating pain located behind the left ear and radiating to the ipsilateral eye, the neck, or shoulder, was admitted for re-evaluation due to additionally manifested short lasting syncope-like episodes of increasing frequency. Beneath a mild residual facial nerve palsy no further focal findings were documented. Extensive cardiologic workup revealed only a positive tilt table test, indicating an intense vagovasal reaction.

Re-evaluation of previously performed imaging examinations focused on an already angiographically described tortuous course of the vertebrobasilar arteries (panel A), which compressed the left lateral surface of the medulla, pons, and pontomedullar junction, as also demonstrated on MRI (panel B). Based on the documented vagovasal reaction we assumed an affection of the lower cranial nerves and additionally performed ultra thin MRI. In this way we could impressively demonstrate a severe compression of the proximal stem of the cranial nerves IX and X (panel D), and the root entry zone of the facial nerve on the left (panel C). Owing to the escalation of symptoms the patient underwent microvascular decompressive surgery with interposition of a muscle graft. Two years later she remains asymptomatic. A repeated tilt table test was this time negative.

This is an uncommon case of neurovascular compression, characterised by known, however previously not in this combination, described features such as hemifacial spasms, variant glossopharyngeal neuralgia, and syncope, which all ceased after surgery.

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Competing interests: none declared

References

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NEUROLOGICAL PICTURE

(A) Superimposed projection of the digital subtraction angiograms of both vertebral arteries demonstrates impressively the tortuous course of the vertebrobasilar vessels (B) Axial T1-GRE weighted MRI sequences demonstrating the tortuous course of both vertebral arteries and their compressing effect on the left frontolateral surface of the pontomedullar junction, the pons, and the cerebellar peduncles. (C) Frontal T1 weighted MRI slice showing the compressing effect of both vertebral arteries (white arrow heads) on the root entry zone of the left facial nerve. (D) Ultra thin (0.8 mm) M3D/FSE weighted MRI slice showing the direct contact between the vertebral artery (black arrow head) and the IX/X cranial nerve (grey arrow).