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Post-mortem 7.0-tesla magnetic resonance study of cortical microinfarcts in neurodegenerative diseases and vascular dementia with neuropathological correlates

J. De Reuck [a,*], V. Deramecourt [a,b,c,h], F. Auger [a,d], N. Durieux [a,d], C. Cordonnier [a,e], D. Devos [a,f,g], L. Defebvre [a,g], C. Moreau [a,g], D. Caparros-Lefebvre [i], R. Bordet [a,f], C.A. Maurage [a,c,h], F. Pasquier [a,b], D. Leys [a,e]

[a] Université Lille Nord de France, UDSL, EA 1046, F-59000 Lille, France
[b] Memory Clinic, Lille University Hospital, F-59000 Lille, France
[c] Pathology Department, Lille University Hospital, F-59000 Lille, France
[d] Imaging Platform, Research Pole, Lille University Hospital, F-59000 Lille, France
[e] Stroke Department, Lille University Hospital, F-59000 Lille, France
[f] Pharmacology Department, Lille University Hospital, F-59000 Lille, France
[g] Movement Disorder Department, Lille University Hospital, F-59000 Lille, France
[h] INSERM U837, F-59000 Lille, France
[i] Centre Hospitalier, F-59150 Wattrelos, France

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ABSTRACT

Background: Until recently cortical microinfarcts (CMIs) were considered as the invisible lesions in clinical–radiological correlation studies that rely on conventional structural magnetic resonance imaging. The present study investigates the presence of CMIs on 7.0-T magnetic resonance imaging (MRI) in post-mortem brains with different neurodegenerative and cerebrovascular diseases.
Materials and methods: One hundred-seventy five post-mortem brains, composed of 37 with pure Alzheimer's disease (AD), 12 with AD associated to cerebral amyloid angiopathy (AD-CAA), 38 with frontotemporal lobar degeneration, 12 with amyotrophic lateral sclerosis, 16 with Lewy body disease (LBD), 21 with progressive supranuclear palsy, 18 with vascular dementia (VaD) and 21 controls were examined. According to their size several types of CMIs were detected on 3 coronal sections of a cerebral hemisphere with 7.0-T MRI and compared to the mean CMI load observed on histological examination of one standard separate coronal section of a cerebral hemisphere at the level of the mamillary body.
Results: Overall CMIs were significantly prevalent in those brains with neurodegenerative and cerebrovascular diseases associated to CAA compared to those without CAA. VaD, AD-CAA and LBD brains had significantly more CMIs compared to the controls. While all types of CMIs were increased in VaD and AD-CAA brains, a predominance of the smallest ones was observed in the LBD brains.
Conclusions: The present study shows that 7.0-T MRI allows the detection of several types of MICs and their contribution to the cognitive decline in different neurodegenerative and cerebrovascular diseases.

1. Introduction

Cortical microinfarcts (CMIs) should best be defined as ischaemic necrosis in the territory of a single cortical penetrating vessel [1]. The arterial angioarchitecture of the cerebral cortex has a columnar distribution composed of perforating branches of different sizes. They can be classified as short-sized cortical branches, ending in the superficial layers, middle-sized branches ending in the third and fourth layers, and long cortico-medullary branches, ending in the deepest cortical layers and in the subcortical white matter [2]. The size and the location of the a CMI will depend on which type of branch had been occluded and varies from 50 μm to less than 2 mm according to different neuropathological studies [3].

Until recently CMIs have been considered as the invisible lesions in clinical–radiological correlation studies that rely on conventional structural magnetic resonance imaging [4]. They are also nearly visible on

* Corresponding author at: Leopold II Laan 96, BE-9000 Ghent, Belgium. Tel.: +32 9 2218844; fax: +32 9 3324971.
E-mail address: dereuck.j@gmail.com (J. De Reuck).

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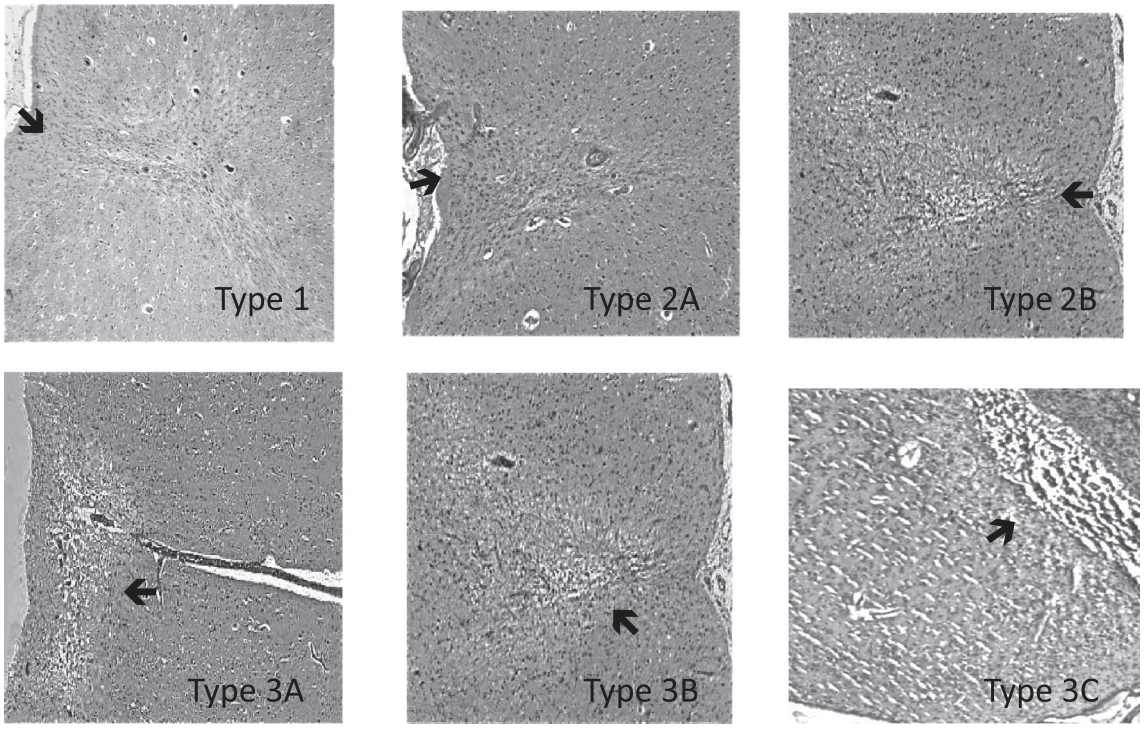

Fig. 1. Types of cortical microinfarcts on neuropathological examination after staining with haematoxylin–eosin. Type I involves all cortical layers, Type 2A the superficial and middle cortical layers, and Type 2B the middle and deep cortical layers and the arcuate fibres. Types 3A, 3B and 3C represent laminar infarcts restricted respectively to the superficial, the middle and the deep cortical layers and arcuate fibres.

naked eye examination of post-mortem brains and best detected by light-microscopic examination [5]. Recently in vivo detection of CMIs has been demonstrated with high-resolution 7.0-T magnetic resonance imaging (MRI) [6].

CMIs usually occur at the latest stage of cerebral amyloid angiopathy (CAA) or of arteriosclerosis [7] and significantly affect cognition in brain aging [8,9].

The present study tries to further validate the detection of CMIs on 7.0-T MRI in a large series of post-mortem brains of patients with various neurodegenerative diseases and with vascular dementia by comparing their frequency and distribution to those observed on histological examination of a separate standard coronal section at the level of the mamillary body. Also the overall impact of CAA on the frequency and distribution of CMIs is investigated.

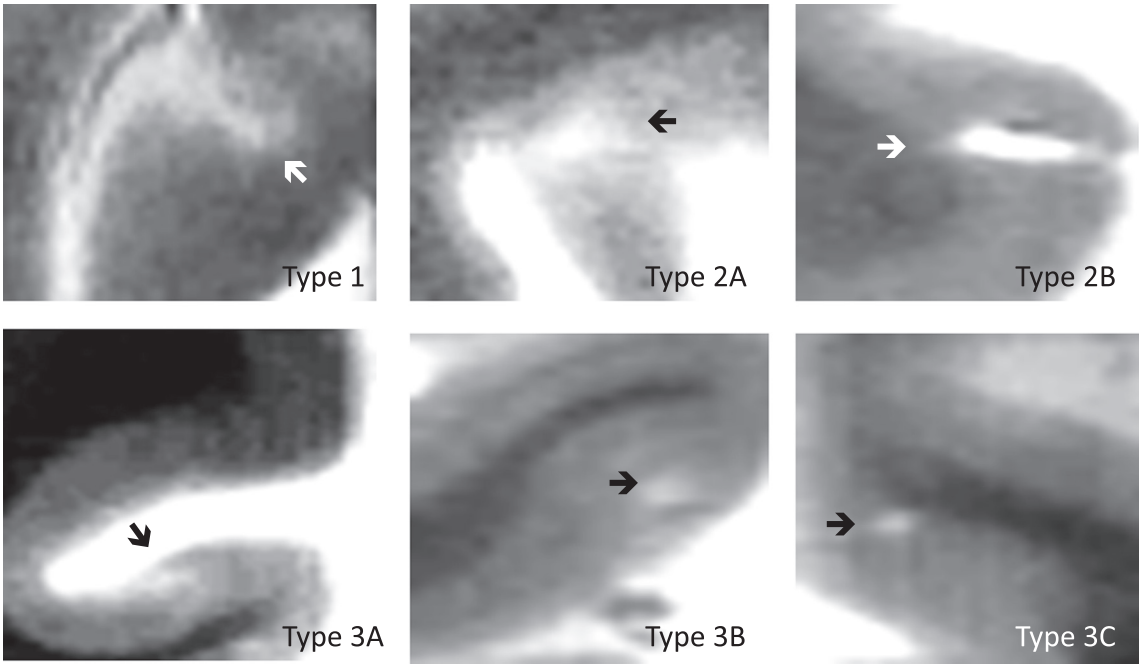

Fig. 2. Magnetic resonance imaging of the six types of the cortical microinfarcts on T2 sequence. Type I involves all cortical layers, Type 2A the superficial and middle cortical layers, and Type 2B the middle and deep cortical layers and the arcuate fibres. Types 3A, 3B and 3C represent laminar infarcts restricted respectively to the superficial, the middle and the deep cortical layers and arcuate fibres.

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