COMPARISON OF OPTICAL COHERENCE MICROSCOPY WITH CONVENTIONAL HISTOLOGY FOR THE DETECTION OF SENILE AMYLOID-BETA PLAQUES IN ALZHEIMER'S DISEASE

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INTRODUCTION

The deposition of senile amyloid beta (Aβ) plaques in the cerebral cortex is a key hallmark of Alzheimer's disease (AD) [1]. Post-mortem histological analysis of different brain regions is conducted to establish the definite diagnosis. However, this histological procedure is both time consuming and prone to artifacts, as it involves several steps of tissue preparation, sectioning and staining. To overcome these challenges, it has been shown that these plaques can also be detected using optical coherence microscopy (OCM) [2, 3]. We investigated the potential and limitations of a high resolution (HR) OCM prototype and a commercial polarization sensitive (PS) OCM system as non-destructive imaging modalities for the detection of senile Aβ plaques in AD. The results were then compared to traditional histology.

METHODS AND RESULTS

We evaluated eleven AD and three control post mortem brain samples. Cortical regions were imaged using the custom-built HR-OCM prototype with an axial resolution of 0.88 µm in brain tissue and a lateral resolution of 4 µm [3], and a commercial PS-OCM system (Thorlabs TEL220PSC2) with an axial resolution of 5.5 µm and a lateral resolution of 20 µm (using the OCT-LK4 objective, Thorlabs). Figure 1(a-c) shows a 3D image, a cross-section and a depth projection of an AD brain sample imaged with the HR-OCM prototype. Plaques appeared as hyper-reflective spots (arrows) in the OCM images and were distributed throughout the tissue. Neuritic plaques cause birefringence, which can be visualized using PS-OCM [2]. Phase retardation images acquired with the PS-OCM system are shown in Fig. 1(d, e). To confirm our findings by histology, brain sections were stained immunohistochemically using an anti-Aβ antibody (clone 6F/3D, diluted 1:100, Dako; Fig. 1(f)) and by Congo red, which binds to neuritic plaques (Fig. 1(g)). Plaques were visualized in three dimensions using serial sectioning (Fig. 1(h)). In conclusion, while PS-OCM can only observe mature congophilic plaques, HR-OCM seems to show a higher number of plaques.

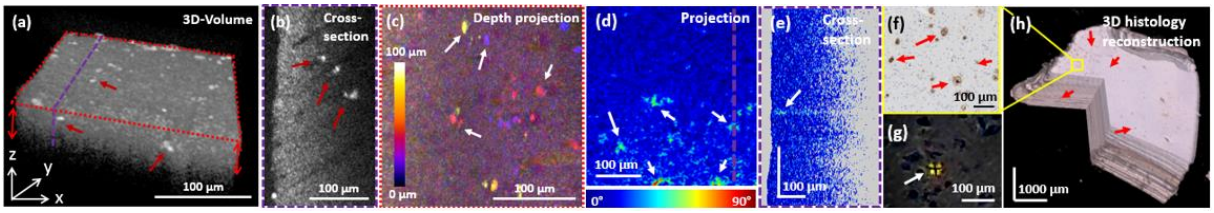

Figure 1: Imaging Aβ plaques in AD brain samples using an OCM. *(a-c) 3D volume, cross-section and depth projection with HR-OCM. PS-OCM projection image (d) and cross-section (e) of compact plaques. (f) Aβ staining. (g) Congo red staining in polarization microscope. (h) 3D reconstruction of plaques in serial sections.*

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