ANATOMICAL BRAIN IMAGING

Application Note

Abstract

The imaging of vasculature in and around a mouse's brain is essential for BLANK. A post-mortem BALC/c mouse with metastasized 4T1-luc is scanned using photoacoustic imaging (PAI) with the PhotoSound TriTom imaging platform. PAI is a non-invasive imaging method that produces high resolution volumetric data of tissue and vasculature. The head of the mouse is imaged at wavelengths of 750 nm and 532 nm.

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Introduction

Photoacoustic imaging (PAI) can best resolve blood-rich anatomical structures, such as deep vessels. A post-mortem BALC/c mouse is scanned using PAI with the TriTom system at wavelengths of 750 nm and 532 nm. The acquired PA data is reconstructed into 3D volumes that are used to visualize vasculature and mass in and around the brain.

Materials and Methods

Mouse Model

A [Find out age], post-mortem, metastasized (4T1-luc) female BALB/c mouse was scanned. While the mouse does have metastasized 4T1-luc, it is not relevant for the brain imaging. A reference PTFE tube filled with $CuSO_4$, μ_{10} = 1.4 (1/cm).

Imaging

The TriTom imaging platform was prepared with the water in the imaging chamber at temperature $T = 37.0 \pm 0.5\ °C$. The mouse subject was placed into a mouse restrainer. The mouse holder is then mounted onto the rotational stage of the TriTom (Figure 1). Several 3D PA tomography (PAT) scans were initiated, each rotating the mouse 360° while acquiring 360±5 frames of PA data at the excitation wavelength of 750 nm and 532 nm.

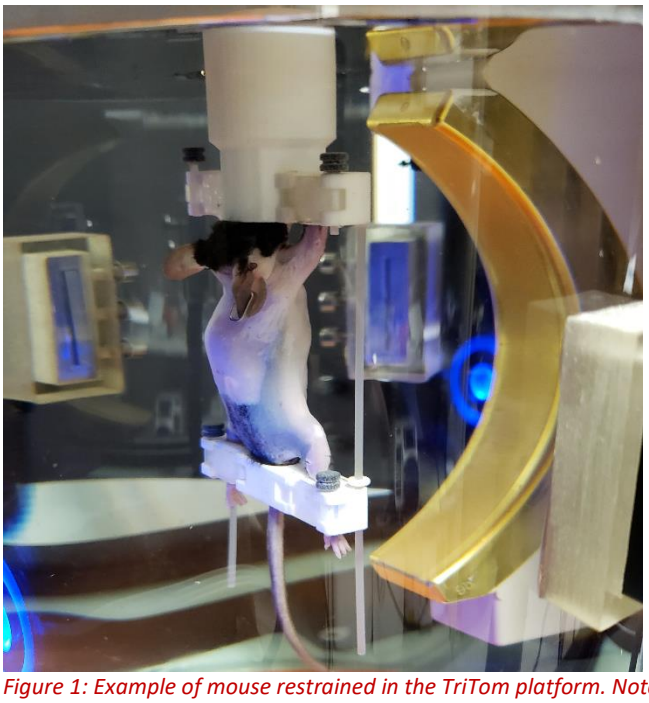

Figure 1: Example of mouse restrained in the TriTom platform. Note, the mouse depicted is not the mouse scanned for this application note.

PAT Reconstruction

The acquired PA data was reconstructed into 30x30x30 mm volumes with a voxel size of 0.1 mm using a filtered back projection method [1].

Results

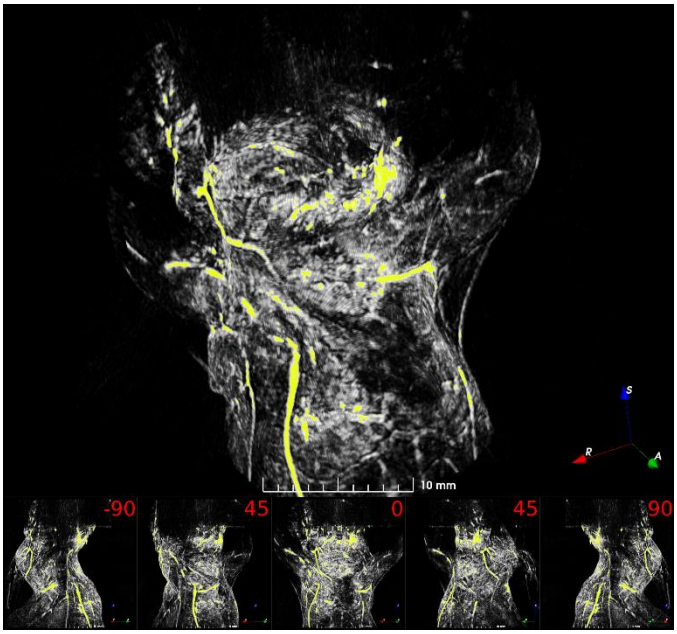

Figure 2: Maximum intensity projection volume render of the scanned mouse at 532 nm. High intensity signals are visualized in yellow. Angle of rotation is displayed in the top-right corner of each view.

Figure 2 shows the reconstruction volume of the 532 nm scan as a reference of the visualized area of the mouse. The two wavelength reconstruction transverse slices are shown side-by-side in Figure 3, where the 532 nm highlights skin and surface vasculature while the 750 nm highlights deep anatomy.

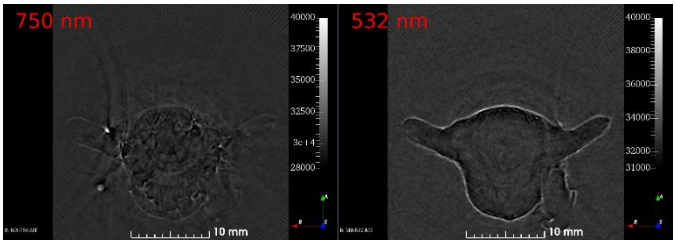

Figure 3: Comparison between transverse slices of the 750 nm and 532 nm reconstructions before overlapping.

Figure 4 details various anatomy of the brain and surrounding features using known anatomical references [2][3][4]. The transverse slices, a superposition of the 750 nm (greyscale) and 532 nm (black-yellow scale) reconstructions, are presented as a

series of panels with 1 mm vertical separation. Note that the image has a resolution of 2536 x 6320, if desired, contact PST for the original image file.

The mouse head 750 nm reconstruction volume is shown in 3D in Figure 5 with a black-white-red scale. The displayed volumes are visualized as 7 mm thick slabs that give depth perspective to the reconstruction data with some high PA amplitude structures labeled.

Finally, a comparison between the PAI results and, from an unrelated dataset, MRI of a mouse brain is shown in Figure 6. The comparison highlights the difference in signal amplitude for different anatomical structures between PAI and MRI. Vasculature and skin are more visible in PAI; grey matter and fat are more visible in MRI.

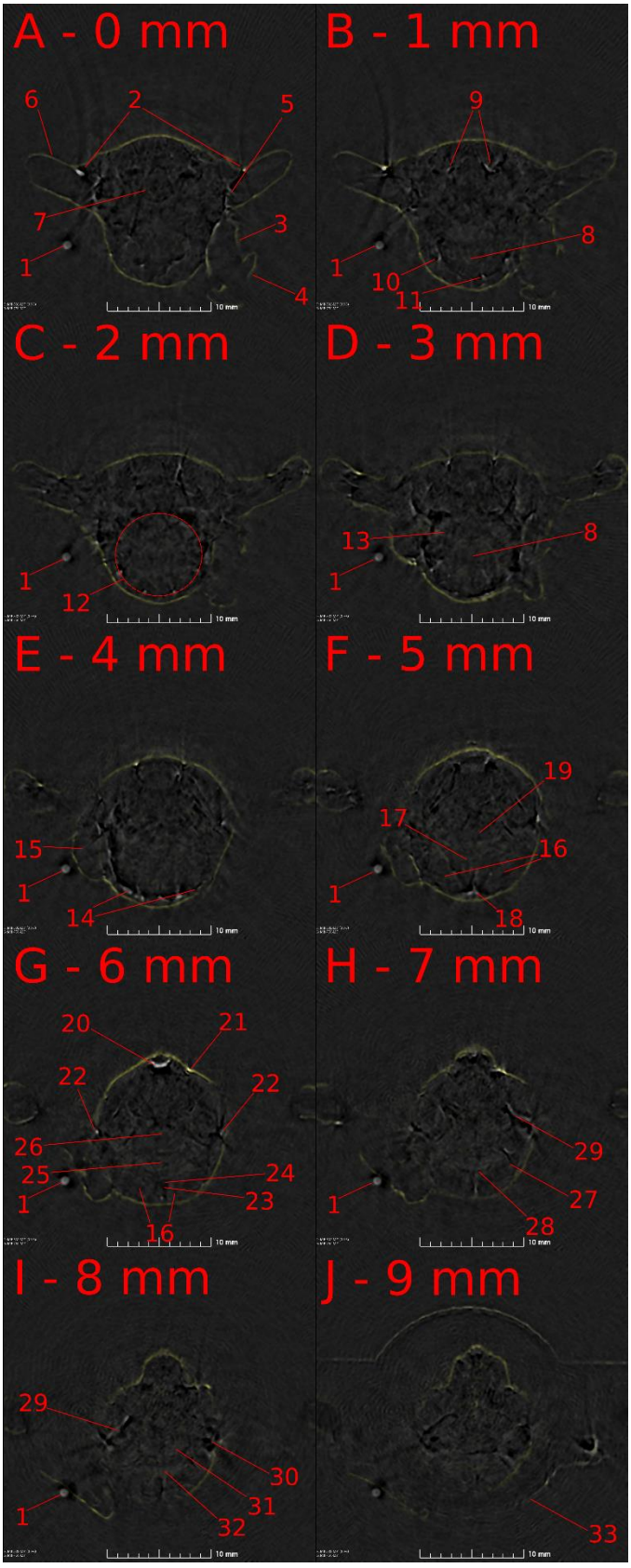

Figure 4: 2D transverse slices of the 750 nm scan (greyscale) with the 532 nm scan (black-yellow scale) overlaid. Sequential slices (A-J) each have a vertical displacement of 1 mm, with (A) towards caudal and (J) towards cranial. (1) $CuSO_4$ PTFE tube; (2) brachial arteries; (3)

left ear skin; (4) metal ear tag; (5) skin crease; (6) arm skin; (7) trachea; (8) cerebellum; (9) external jugular; (10) auricular artery; (11) cerebral artery; (12) outline of brain; (13) medulla; (14) transverse sinus; (15) right ear; (16) telencephalon; (17) mesencephalon; (18) confluence of sinus; (19) pons; (20) sublingual vein; (21) facial vein; (22) superficial temporal vein; (23) subarachnoid space; (24) third ventricle; (25) thalamus; (26) hypothalamus; (27) parietal bone; (28) corpus callosum; (29) condyloid process (?); (30) left eye; (31) optic tract; (32) ventral hippocampal commissure; (33) mouse restrainer.

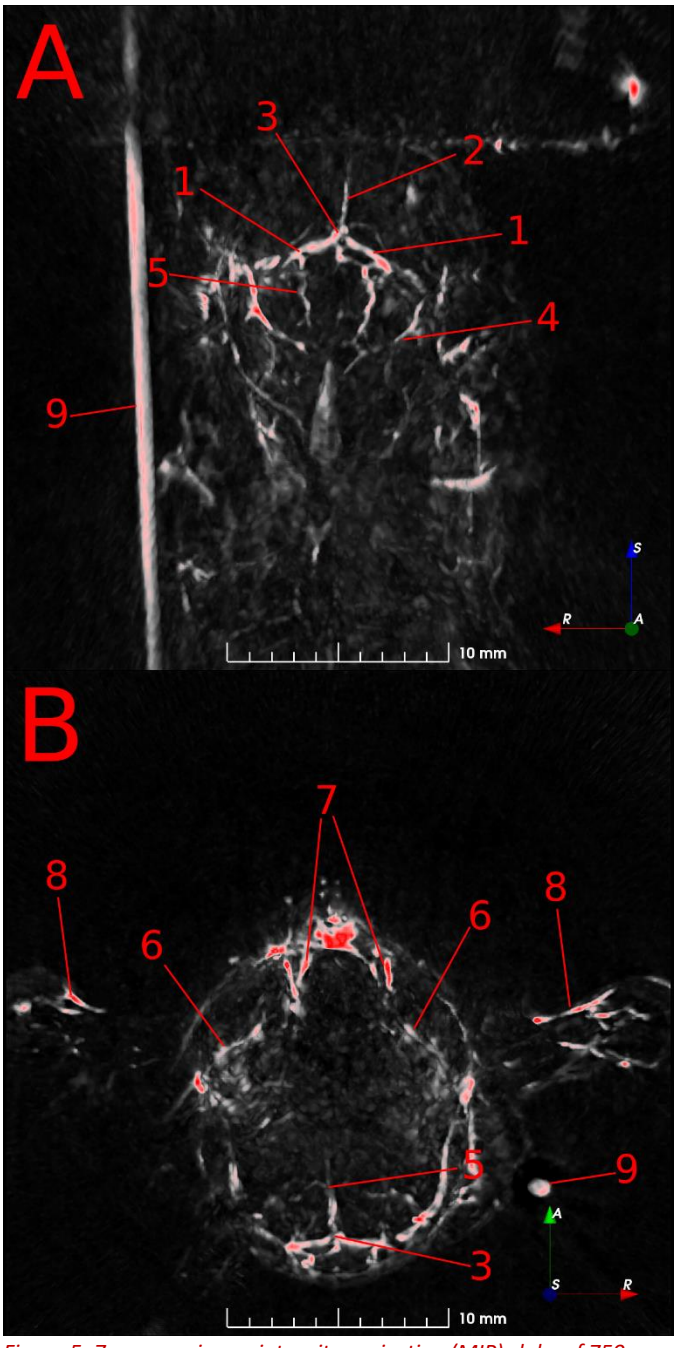

Figure 5: 7 mm maximum intensity projection (MIP) slabs of 750 nm excitation PA reconstruction volumes. A: Dorsoventral view of the mouse's scalp. B: Transverse view of mouse's brain near the cerebellum/medulla. (1) transverse sinus; (2) superior sagittal sinus; (3) confluence of sinus; (4) auricular artery; (5) cerebral artery; (6) ophthalmic artery; (7) jugular vein; (8) brachial artery; (9) $CuSO_4$ tube.

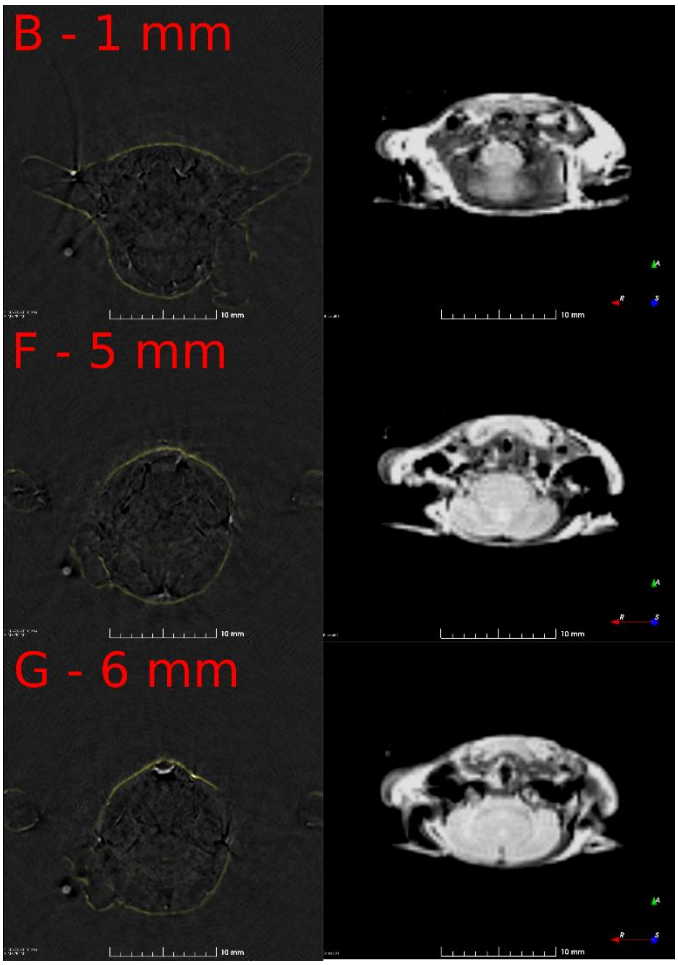

Figure 6: Comparison between PAI and MRI of similar position brain slices. Note that different mice were used for each imaging modality.

References

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