Neuronal Architecture as a Biomarker for Blast Exposure

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Introduction

- Recent methods improve objective spine classification (Risher et al., 2014; Roy, A., & Sharma, B et al., 2023)
- Dendritic spines form excitatory synapses; filopodia mature into mushrooms during development (Nimchinsky et al., 2002; Holtmaat et al., 2005)
- Abnormal spine morphology linked to neurodevelopmental disorders
- We quantify Golgi-stained dendrite and spine parameters after blast injury.
- Hypothesize reduced arborization and spine density, reflecting impaired synaptic development.

Objective

To determine which morphological parameters of Golgi-stained neurons in the cortex and vestibular nuclei can serve as valuable indicators of synaptic plasticity following blast injury.

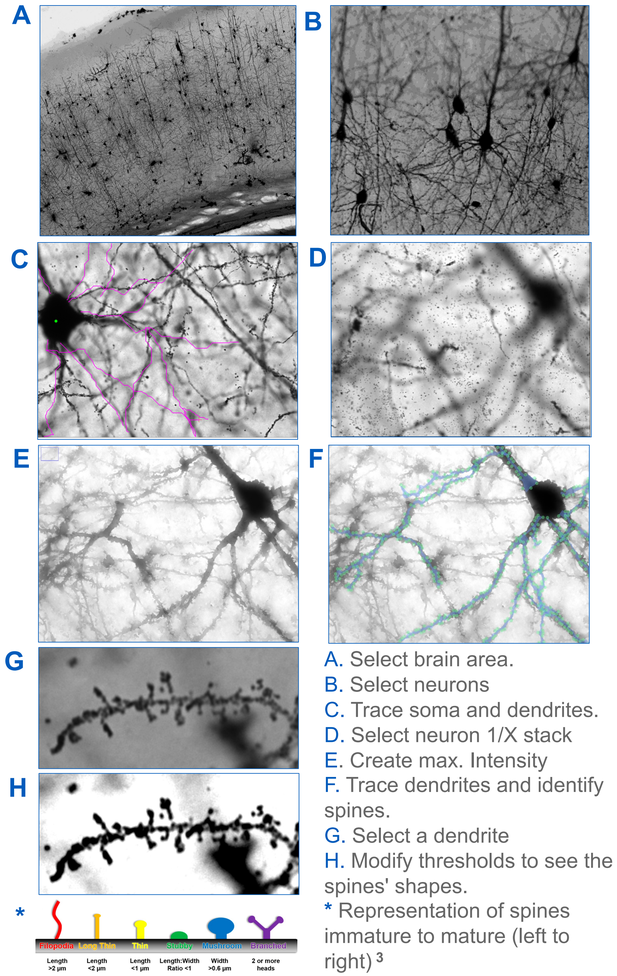
Methods

The analysis was acquired at 100x from the Golgi-stained brain sections from normal rats. Data collection started by following the Golgi-Cox staining protocol [4]. The software to optimize the image was Fiji[5], with an SNT plugin and Dendritic Spine Counter to measure each neuron.

Data Analysis

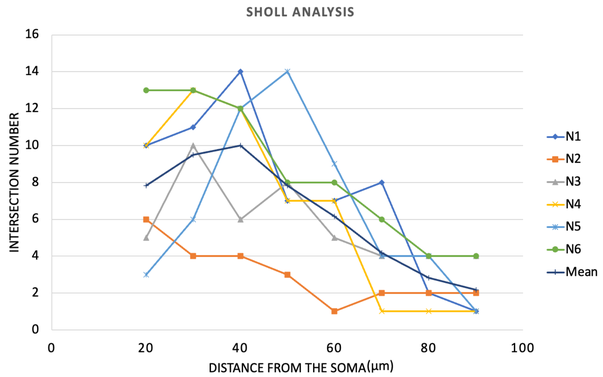
We used descriptive statistics and then created graphs to observe the behavior in each variable.

Step by step, Sholl Analysis and Dendritic Spine counter



A. Select brain area.
B. Select neurons
C. Trace soma and dendrites.
D. Select neuron 1/X stack
E. Create max. Intensity
F. Trace dendrites and identify spines.
G. Select a dendrite
H. Modify thresholds to see the spines' shapes.
* Representation of spines immature to mature (left to right) [3]

Results



Plot. Sholl analysis was performed on six neurons to quantify dendritic complexity. Concentric circles were drawn around the cell body, starting at a radius of 20 µm (approximate soma diameter) and increasing in 10 µm intervals. This data represents the dendritic arborization patterns and can be compared between experimental conditions to assess changes in neuron morphology.

Discussion

- Neuronal morphology analysis is proposed as a helpful method for evaluating synaptic plasticity after neurological conditions like TBI (Antons et al., 2021)
- Golgi staining with morphometric analysis shows dendrite and spine changes after TBI (Risher et al., 2014) and blast exposure (Antons et al., 2021)
- Quantifying dendrite branching, spine density, and morphology could be structural biomarkers of deficits and recovery after blast TBI.

Conclusion

Advanced morphometric analysis of Golgi-stained neurons has significant potential to elucidate synaptic plasticity and circuit reorganization following blast neurotrauma.

Future Directions

Our goals are to analyze the **Dendritic Length, Spine Count, Spine Density, Sholl Analysis**

References

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