Estimation of Shape and Orientation of Neurons in Thick Histological Sections by Volume Tensors

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Introduction

Alteration in the morphology of neurons from tissue sections in cortical layers of rat and human brain has been shown in neuropsychiatric disorders. We applied “Volume Tensors” to investigate shape, orientation and volume of neurons in histological sections from prelimbic (PL) cortex of the Flinders Sensitive Line (FSL) rat (genetic animal model of depression) and Flinders Resistant Line as well as FSL-maternal separated (FSL-MS) rats.

Materials and Methods

A tissue block containing the whole PL region from each rat was embedded in glycol methacrylate and cut coronally into parallel 140 µm thick plastic sections. Sections were stained with 10% thionin, using a special protocol developed for thick plastic sections, and two sections were sampled systematically. The corresponding layer-III of the prelimbic region of rat PL was delineated using a 4× objective. Approximately 200 neurons per rat brain were sampled systematically with the nucleolus as a counting unit by the optical disector using a 60x oil objective. The vertical optical rotator probe was applied in relation to the cortical surface, to obtain 3D coordinates of the neurons collected at three different optical planes with a distance of 1.67 µm. The data from the two thick sections cut from each rat were pooled and estimates of the average neuronal volume, displacement vector and Miles ellipsoid were calculated from each rat.

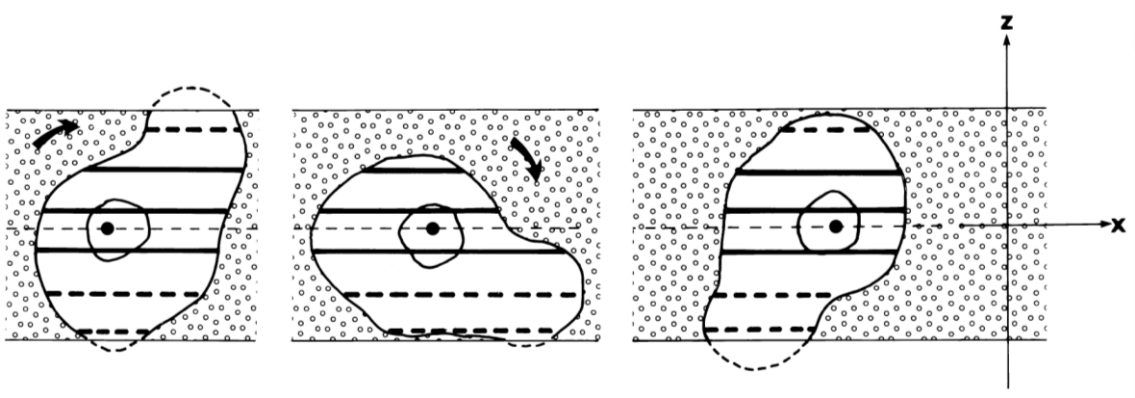

Figure 1. The optical disector samples the nucleolus of the neuron and a virtual slice with the origin in the nucleolus and parallel to the thick section is placed. 3D coordinates from cell borders at three optical planes are now collected. From figure 5 in Tandrup et al. 1997.

Results and Discussion

The analysis of neuronal shape showed an elongation of the Miles ellipsoid in the vertical direction in FRL and FSL groups ($2p < 0.02$), while in the FSL-MS group; the hypothesis of a spherical shape was accepted ($2p > 0.05$).

Conclusion

It seems that Volume Tensors may be useful in investigating morphological alterations in neurons. Apparently, the shape of neurons in layer-III of mPFC is elliptical in FRL and FSL rats, whereas maternal separation changes it into a more spherical shape. The importance and neurobiological meaning of this structural change in neuronal shape following maternal separation is unknown.

References

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