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Methodical Approaches to Visual Display of Cell Size and Shape

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Abstract

The method for visually displaying the size and shape of a cell, proposed in this article, allows to improve and supplement the methodology for studying the consequences of experimental cerebral ischemia and other experimental pathologies. It allows you to visually and comprehensively assess the dynamics of changes in the size and shape of the cell.

Keywords: Methods; Visual display; Cells

Introduction

The size and shape of a cell, in particular, a neuron, reflects its morphological and functional characteristics. It is known that under pathological influences, the cell can swell or, conversely, shrink, change shape [1,2,4,5,6,8]. Usually, to display the size and shape of a cell, bar and line charts are used, built on the basis of numerical data on its area, form factor, and elongation factor, obtained by morphometry using the Image Warp image analysis computer program (Bitflow, USA) [1,2]. However, this method has a disadvantage associated with the inability to visualize changes in the size and shape of the cell, and therefore there is a need to develop an adequate method for visual representation of changes in the size and shape of the cell [3,6,7,9,10].

To visually display the shape of the cell, an oval geometric figure template was used in the MS Word program. The program uses the "width" and "height" parameters to determine the size of the shape. The width and height of the oval were set in the "Size" shape properties window in proportion to the geometric dimensions of the cell.

To determine the geometric dimensions of the cell, the following approach was used: the cell was considered as an ellipse with the major semiaxis and the minor semiaxis b. The area of the ellipse in this case is found by the formula:

$$S = \pi ab$$

The cell elongation factor is defined as the ratio of the largest cell diameter to its smallest diameter:

$$f = D\max / D\min$$

Since the cell is considered as an ellipse, the last relation can be rewritten as:

$$f = D\max / D\min = (2a) / (2b) = a / b$$

The cell area and the elongation factor are known from the readings of the Image warp image analysis program (Bitflow, USA), so we obtain a system of two equations with two unknowns a and b:

$$\begin{cases} S = \pi ab \\ f = a / b \end{cases}$$

The solution of this system allows us to determine the values of a and b:

$$b = \sqrt{s / (\pi f)}$$

$$a = fb$$

Further, the size of the oval in the MS Word program is set in proportion to the found values: width (W, cm) - proportional to a, height (H, cm) - b. For several cells to be set on the same scale, the following formulas were used:

$$W, cm = a / a_c .Kcm$$

$$H, cm = b / b_c .Kcm$$

Where W, cm, H, cm are the width and height of the oval in cm, a_c is the half-width of the control cell, b_c is the half-height of the control cell, 4.7 cm is the width of the control cell displayed on the screen, K is the scaling factor for the height, determined by as K=b_c/a_c·4.7, a and b are the half-width and half-height of the cell (Table 1 to 4).

Table 1: Sizes and shapes of neurons in the parietal cortex and hippocampus of rats with total ischemia (TCI).

Animal Groups	Areas of The Cerebral Cortex	
	Parietal Cortex	Hippocampus
	Area, μm²	
control	145(130;154)	109(100;122)
1 hour TCI	37(27;47)*	54(50;60)
1 day TCI	24(23;25)	26(24;28)
Elongation Factor, Units		
control	1,2(1,1;1,2)	1,2(1,2;1,2)
1 hour TCI	1,8(1,7;1,8)	1,8(1,8;1,9)
1 day TCI	2,4(2,3;2,5)	2,3(2,1;2,4)
Form Factor, Unit		
контроль	0,9(0,9;0,9)	0,9(0,9;0,9)
1 hour TCI	0,6(0,6;0,6)	0,6(0,5;0,6)
1 day TCI	0,6(0,5;0,6)	0,5(0,5;0,6)

Table 2: Ellipse dimensions (length | height).

	Parietal Cortex		Hippocampus	
	Ellipse Dimensions (Length | Height)			
Control	7,44	6,20	6,45	5,38
1 hour TCI	4,60	2,56	5,56	3,09
1 day TCI	4,28	1,78	4,36	1,90

Table 3: Ellipse dimensions (Length | Height), Mm.

	Parietal Cortex		Hippocampus	
	Ellipse Dimensions (Length | Height), Mm			
Control	47	39	41	34
1 hour TCI	29	16	35	19
1 day TCI	27	11	28	12

Table 4: Shapes of neurons.

Animal Groups	Parietal Cortex	Hippocampus
Control	145(130;154)	109(100;122)
1 hour TCI	40(33;44)	54(50;60)
1 day TCI	24(23;25)	26(24;28)

Thus, the proposed method for visually displaying the size and shape of a cell makes it possible to graphically represent its size and shape, which is important for detailing the changes that occur in the pathology under study. This method is simple to implement, does not require additional equipment, does not cause additional material costs.

Acknowledgement

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Conflict of Interest

No conflict of interest.

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