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HISTOLOGY AND REGENERATION POTENTIAL OF NERVOUS TISSUE

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Abstract: Nervous tissue is considered the most complex and specialized tissue in the human and animal body. It consists of nerve cells—neurons—and supportive glial cells, and it forms both the central (brain and spinal cord) and peripheral (peripheral nerves and ganglia) nervous systems. The main function of nervous tissue is to receive, transmit, and respond to information from both external and internal environments. Its morphological structure and cellular/tissue-level organization play a crucial role in the performance of its physiological functions.

The regeneration of nervous tissue, i.e., its ability to recover after injury, is one of the most pressing areas of modern neurobiology. The regenerative potential of the central nervous system (CNS) is significantly lower than that of the peripheral nervous system (PNS). This implies a limited capacity for full recovery after injuries to the brain or spinal cord. In contrast, the peripheral nervous system, particularly due to the activity of Schwann cells, demonstrates a comparatively higher regenerative capacity. This difference is mainly attributed to the presence or absence of factors within the tissue microenvironment that either promote or inhibit regeneration.

Recent studies have shown that, although limited, neurogenesis—the formation of new neurons—also occurs in the central nervous system. Neuroblast formation has been particularly observed in the hippocampus and the subventricular zones surrounding the lateral ventricles in adults. This suggests that nervous tissue has a certain potential for self-repair under specific conditions. However, such processes are typically slow and rarely lead to complete regeneration.

One of the main obstacles to regeneration in the CNS is the formation of glial scars (gliosis) caused by the proliferation of glial cells, especially astrocytes, at the injury site. These scars act as physical and chemical barriers that restrict nerve impulse transmission and axon growth. Therefore, many modern studies aim to overcome these barriers, identify biomolecules that stimulate regeneration, and enhance neuronal recovery using neurotrophic factors.

This article analyzes the histological structure of nervous tissue, the interaction between neurons and glial cells, mechanisms of regeneration, differences between the CNS and PNS, and modern therapeutic and restorative approaches (including neurostimulation, biomaterials, and stem cell therapy). It also explores recent experimental and clinical advancements as well as the existing challenges in the field of neural regeneration.

A deeper understanding of the regenerative potential of nervous tissue not only helps address challenges in surgery, traumatology, and neurology but also lays a scientific foundation for the future treatment of neurodegenerative diseases.

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Keywords: Nervous tissue, neurons, glial cells, regeneration, central nervous system (CNS), peripheral nervous system (PNS), neurogenesis, gliosis, Schwann cells, astrocytes, axonal regeneration, neurotrophic factors, histological structure, nerve injury, nerve repair, biomaterials, stem cells, neurostimulation, cellular plasticity, microenvironment, functional recovery.

Introduction

In modern biomedical science, studying nervous tissue and its regenerative capabilities is considered one of the most relevant scientific challenges. Nervous tissue is responsible for controlling the functional activity of the human and animal body by receiving, processing, and responding to stimuli from both external and internal environments. It mainly consists of neurons and supportive glial cells, whose morphological and functional interactions form the basis of both the central and peripheral nervous systems.

Unfortunately, compared to other tissues in the body, nervous tissue has limited regenerative capacity. This is particularly evident in the central nervous system (brain and spinal cord), where tissue recovery after injury is extremely restricted. As a result, neurological diseases, strokes, traumatic injuries, and neurodegenerative processes often lead to high disability and mortality rates. The peripheral nervous system, under certain conditions, shows a comparatively higher regenerative potential, largely due to the activity of Schwann cells.

In recent years, extensive research has been conducted on the histological structure of nervous tissue, the regenerative potential of neurons and glial cells, and the identification of regeneration-stimulating factors. In this context, comparing the regeneration mechanisms of the central and peripheral nervous systems, analyzing their histological characteristics, and evaluating cellular-level recovery processes have become critically important in scientific studies.

This research is aimed at studying the microstructure of nervous tissue, responses to injury, regenerative capabilities, and the identification of both inhibitory and stimulatory factors affecting regeneration. It serves as a theoretical foundation for developing new therapeutic approaches to treat nervous system-related diseases in the future.

Research Methods

This study comprehensively examined the histological structure of nervous tissue and its regeneration processes using integrated experimental, morphological, and statistical analysis methods.

1. **Experimental Model:**

Laboratory mice were selected to conduct experiments on regeneration in both the CNS and PNS. The animals were divided into control (healthy) and experimental (nerve-injured) groups. Nerve damage models were created using surgical techniques to cut or crush nerves.

2. **Histological Methods:**

Histological sections were prepared to study the microstructure of nervous tissues. Hematoxylin-eosin, Nissl stain, Golgi stain, and immunohistochemical techniques were used

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to examine neurons, glial cells, axons, and synapses under a microscope. Particular focus was placed on gliosis and Schwann cell activity during regeneration.

3. **Electron Microscopy:**

To study ultrastructures, scanning and transmission electron microscopy were used. These allowed observation of changes in cell organelles, synaptic contacts, and the myelin sheath during regeneration.

4. **Immunohistochemistry:**

Immunolabeling with markers such as GFAP (astrocyte marker), S100 (Schwann cell marker), NeuN (neuronal nuclei marker), and BrdU (proliferating cells) was used to assess cell activity and proliferation levels.

5. **Statistical Analysis:**

Data were statistically analyzed using arithmetic mean, standard deviation, Student's t-test, and ANOVA. A p-value < 0.05 was considered statistically significant.

6. **Literature Review:**

Contemporary scientific articles, monographs, and research published in international journals were reviewed to understand molecular and cellular mechanisms of regeneration. Studies on therapies that stimulate regeneration or prevent neurodegeneration were also analyzed.

Results

The study yielded the following significant scientific findings about the histological structure and regenerative potential of nervous tissue:

1. In the CNS, full regeneration of nerve cells after injury was not observed. Histological studies showed the formation of glial scars due to the proliferation of astrocytes and microglia, which hinder axon growth.
2. In the PNS, proliferation of Schwann cells, remyelination around degenerating axons, and the formation of regeneration pathways were observed. These processes were confirmed using Schwann cell markers (S100).
3. Immunohistochemical tests showed a significant decrease in NeuN expression in injured CNS areas, indicating neuronal loss or reduced activity. In contrast, this marker remained in the PNS, reflecting active axonal regeneration.
4. Electron microscopy revealed myelin degradation and synaptic disruption in the CNS, whereas gradual remyelination and synapse restoration were seen in the PNS after injury.
5. BrdU labeling confirmed active cell proliferation. Glial cells (especially astrocytes) predominated in the CNS, whereas Schwann cell proliferation was dominant in the PNS.
6. All results were statistically significant ($p < 0.05$), validating the scientific reliability of the experimental models used.

Conclusion

This study thoroughly analyzed the histological structure and regenerative potential of nervous tissue. The results demonstrate that regeneration varies significantly between the CNS and PNS. In the CNS, neuronal self-repair is limited, and gliosis often hinders regeneration and functional recovery. In the PNS, Schwann cells serve as the main regenerative component, guiding axon growth and remyelination.

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The findings reveal important histological and cellular changes following nerve injury. The use of staining techniques, immunohistochemical markers, electron microscopy, and cell proliferation indicators (BrdU) were essential in evaluating the degree of regeneration. Particularly, the analysis of cell division, synapse recovery, remyelination, and neuronal marker activity enabled accurate assessment of regenerative capacity.

The key scientific conclusion of this study is that while nervous tissue is not fully capable of self-regeneration, it can be stimulated using molecular agents, cell therapies, biomaterials, or genetic interventions. Future research in this field is vital for developing innovative treatments for nervous system injuries and disorders.

References:

1. Cajal, S. R. y. (1928). Degeneration and Regeneration of the Nervous System. Oxford University Press.
2. Jessen, K. R., & Mirsky, R. (2005). The origin and development of glial cells in peripheral nerves. Nature Reviews Neuroscience, 6(9), 671–682.
3. Ming, G., & Song, H. (2005). Adult neurogenesis in the mammalian central nervous system. Annual Review of Neuroscience, 28, 223–250.
4. Temple, S., & Alvarez-Buylla, A. (2012). Stem cells in the adult mammalian central nervous system. Annual Review of Cell and Developmental Biology, 28, 463–489.
5. Silver, J., & Miller, J. H. (2004). Regeneration beyond the glial scar. Nature Reviews Neuroscience, 5(2), 146–156.
6. Park, K. I., Teng, Y. D., & Snyder, E. Y. (2019). Stem cells in neural regeneration. Annual Review of Neuroscience, 35, 415–436.
7. Gage, F. H., et al. (2020). Adult neurogenesis and regeneration in the central nervous system. Journal of Clinical Investigation, 130(2), 499–507.
8. Matveev, V. V., & Knyazev, E. A. (2016). Molecular Histology of the Nervous System. Moscow: Nauka.
9. Bozorov, B. B., & Karimov, I. I. (2021). Regeneration and restoration challenges of nervous tissue. Journal of Medicine and Biology, 4(2), 85–90.
10. Gulyamov, A. A., & Sodiqov, T. T. (2022). Modern approaches in neurohistology. Scientific Bulletin of UzNU, 5(1), 33–38.
11. Kim, D. H., & Zahir, T. (2017). Biomaterials for neural regeneration. Trends in Biotechnology, 35(7), 571–582.
12. Yuldasheva, G. Sh. (2020). Regeneration processes in nervous system injuries. Theory and Practice of Medicine, 3(1), 91–96.
13. Geuna, S., Raimondo, S., & Ronchi, G. (2009). Histological techniques for the study of peripheral nerve regeneration. Microscopy Research and Technique, 72(4), 248–257.
14. Liu, K., Tedeschi, A., Park, K. K., & He, Z. (2011). Neuronal intrinsic mechanisms of axon regeneration. Annual Review of Neuroscience, 34, 131–152.