Fibrotic Response of Device Implantation on the Sciatic Nerve of Rats

Nusayba El-Ali
Dr. Romero Ortega, Regenerative Neurobiology and Neuroelectronics Laboratory

UNIVERSITY OF HOUSTON

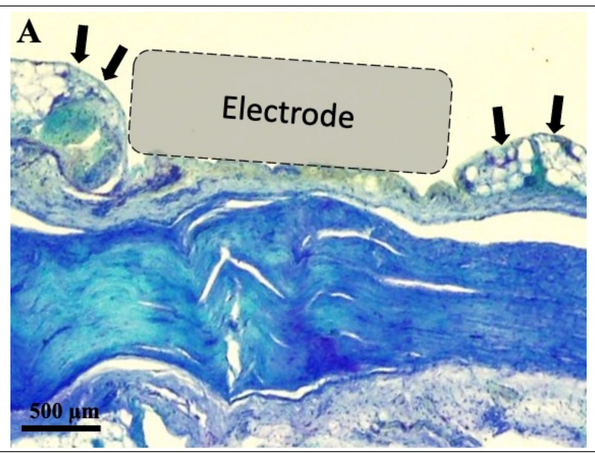
Introduction

The use of implantable devices for neuromodulation has the potential to revolutionize the treatment of various neurological disorders. However, one of the main challenges associated with implantable devices is the foreign body response, which can lead to fibrotic tissue growth and potentially impair the long-term viability of the device. Fibrosis may also indicate that the body is accepting the device and integrating it within itself. In this study, we investigated the foreign body response of fibrosis surrounding the electrode implant area in the sciatic nerve of rats 30 days after device implantation.

Methodology

Four rats were implanted with an electrode device in the sciatic nerve. Thirty days after implantation, the rats were sacrificed, and their sciatic nerves were explanted. Tissue samples were prepared by cryopreservation with sucrose and frozen in OCT medium. The samples were then sectioned using a cryostat machine to obtain longitudinal or cross-section samples. To visualize fibrotic tissue growth surrounding the implant area, the sections were stained with toluidine blue using a multichromatic staining technique. The staining process involved washing and developing various solutions. The stained tissue samples were analyzed using confocal microscopy and immunofluorescence techniques. Fibrotic tissue growth was quantified using paired t-tests to compare areas lateral to the electrode implant with the electrode implant area.

Results



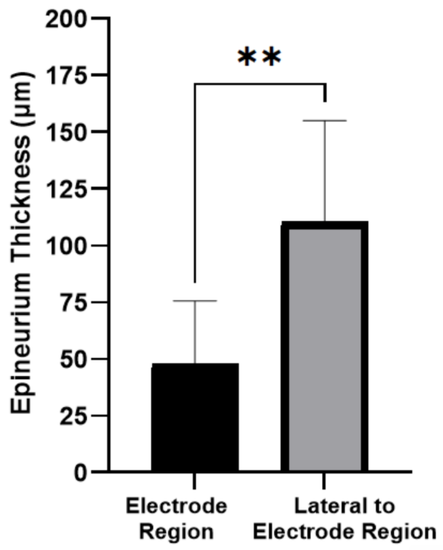


Figure 1. Fibrosis in explanted sciatic nerve 30 days after device implantation. **(a)** Multichromatic staining with toluidine blue applied to show foreign body response of fibrosis surrounding the implant area. The grey rectangle represents the electrode region. Arrows points towards fibrotic tissue growth in the areas lateral to the electrode region. **(b)** Significantly higher amounts of fibrotic tissue growth (paired t-test; **p<0.05, n=4) is shown in areas lateral to the electrode implant compared to the electrode implant area.

Discussion

• The study shows that there is a significant amount of fibrotic tissue growth surrounding the electrode implant area in the sciatic nerve of rats 30 days after device implantation, suggesting a foreign body response to the implanted device.

• Fibrosis is a common response to implanted devices, and it can lead to the formation of scar tissue, which may impair the device's functionality over time. Therefore, the finding of fibrosis raises concerns about the long-term viability of the implanted device.

• However, it is also possible that fibrosis indicates that the body is accepting and integrating the device within itself. This could be a positive sign that the device is becoming a part of the body and functioning as intended.

• Our study did not investigate the performance of the implanted device in relation to fibrosis. Further studies could investigate the relationship between fibrosis and the performance of the implanted device to determine if fibrosis is a reliable indicator of device function or dysfunction

• Additionally, the mechanisms underlying tissue-material interactions are complex and not fully understood. Further research is needed to better understand the processes that lead to fibrosis and how it may affect the performance of implanted devices.

Conclusion

In conclusion, our findings demonstrate that there is a significant amount of fibrotic tissue growth in areas lateral to the electrode implant compared to the electrode implant area 30 days after device implantation. While fibrosis may indicate foreign body response and potential complications for the long-term viability of the device, it is also possible that the body is accepting and integrating the device within itself. Future studies could investigate the relationship between fibrosis and the performance of the implanted device. Overall, our results highlight the importance of monitoring the foreign body response following device implantation and further understanding the mechanisms underlying tissue-material interactions.

References

[1] Gonzalez-Gonzalez, M. A., Romero, K., Beitter, J., Lloyd, D., Lam, D. V., Hernandez-Reynoso, A. G., Kanneganti, A., Kim, H.-K., Bjune, C. K., Smith, S., Vongpatanasin, W., & Romero-Ortega, M. I. (2022). Renal Nerve Activity and Arterial Depressor Responses Induced by Neuromodulation of the Deep Peroneal Nerve in Spontaneously Hypertensive Rats. In Frontiers in Neuroscience (Vol. 16). Frontiers Media SA. https://doi.org/10.3389/fnins.2022.726467

[2] Henderson, N. C., Rieder, F., & Wynn, T. A. (2020). Fibrosis: from mechanisms to medicines. In Nature (Vol. 587, Issue 7835, pp. 555–566). Springer Science and Business Media LLC. https://doi.org/10.1038/s41586-020-2938-9