

BioNanoScience 2017 vol.7 N1, pages 170-176

---

# Multiplex Analysis of the Activation of the Immune System after Transection of the Rat's Sciatic Nerve

Masgutova G., Martynova E., Masgutov R., Mukhametova L., Mullakhmetova A., Kadyrova G., Khaiboullina S., Rizvanov A.

Kazan Federal University, 420008, Kremlevskaya 18, Kazan, Russia

---

## Abstract

© 2016, Springer Science+Business Media New York. In this study, using the model of sciatic nerve transection in rats, the cytokine profile of peripheral blood serum and rat sciatic nerve fragments was measured 3, 7 and 14 days after the injury. Histological analysis of sciatic nerve longitudinal sections was carried out at the same periods of time. The cytokine profile of peripheral blood serum of an intact rat as well as the cytokine profile of an intact homogenized sciatic nerve of a rat was examined. Comparative study of changes in quantitative measures before and after the injury was carried out. It was shown that in peripheral blood serum after the sciatic nerve transection, there was a change in quantitative measures of IL1a, Leptin, IL6, MCP1, and MIP2. In the samples of the rat sciatic nerve, the changes were found in the levels of EGF, Fractalkine, GCSF, IFNg, IL10, IL17A, IL18, IL2, IL6, IP10, Leptin, LIX, MCP1, MIP1a, MIP2, and RANTES.

<http://dx.doi.org/10.1007/s12668-016-0332-8>

---

## Keywords

Cytokines, Multiplex, Rats, Sciatic nerve injury

## References

- [1] Litteljohn, D., & Hayley, S. (2012). Cytokines as potential biomarkers for Parkinson's disease: a multiplex approach. *Methods in Molecular Biology*, 934, 121-144.
- [2] Lees, J. G., Duffy, S. S., Moalem-Taylor, G. (2013). Immunotherapy targeting cytokines in neuropathic pain. *Frontiers in Pharmacology*, 4, 142.
- [3] Woolf, C. J. (2010). What is this thing called pain? *Journal of Clinical Investigation*, 120, 3742-3744.
- [4] Welin, D., Novikova, L. N., Wiberg, M., Kellerth, J. O., Novikov, L. N. (2008). Survival and regeneration of cutaneous and muscular afferent neurons after peripheral nerve injury in adult rats. *Experimental Brain Research*, 186(2), 315-323.
- [5] Miller, R. J., Jung, H., Bhangoo, S. K., White, F. A. (2009). Cytokine and chemokine regulation of sensory neuron function. *Handbook of Experimental Pharmacology*, 194, 417-449.
- [6] Mika, J., Zychowska, M., Popiolek-Barczyk, K., Rojewska, E., Przewlocka, B. (2013). Importance of glial activation in neuropathic pain. *European Journal of Pharmacology*, 716, 106-119.
- [7] Whitehead, K. J., Smith, C. G., Delaney, S. A., Curnow, S. J., Salmon, M., Hughes, J. P. (2010). Dynamic regulation of spinal pro-inflammatory cytokine release in the rat in vivo following peripheral nerve injury. *Brain, Behavior, and Immunity*, 24, 569-576.
- [8] Jun-Ming, Z., & Jianxiong, A. (2007). Cytokines, inflammation and pain. *International Anesthesiology Clinics*, 45(2), 27-37.

- [9] Pakyari, M., Farrokhi, A., Maharlooei, M. K., Ghahary, A. (2013). Critical role of transforming growth factor beta in different phases of wound healing. *Advances Wound Care (New Rochelle)*, 2(5), 215-224.
- [10] Austin, P. J., & Moalem-Taylor, G. (2010). The neuro-immune balance in neuropathic pain: involvement of inflammatory immune cells, immune-like glial cells and cytokines. *Journal of Neuroimmunology*, 229, 26-50.
- [11] Copray, J. C., Mantingh, I., Brouwer, N., Biber, K., Küst, B. M., Liem, R. S., et al. (2001). Expression of interleukin-1 beta in rat dorsal root ganglia. *Journal of Neuroimmunology*, 118, 203-211.
- [12] Lara-Ramirez, R., Segura-Anaya, E., Martinez-Gomez, A., Dent, M. A. (2008). Expression of interleukin-6 receptor alpha in normal and injured rat sciatic nerve. *Neuroscience*, 152, 601-608.
- [13] Klein, M. A., Möller, J. C., Jones, L. L., Bluethmann, H., Kreutzberg, G. W., Raivich, G. (1997). Impaired neuroglial activation in interleukin-6 deficient mice. *Glia*, 19, 227-233.
- [14] Zhang, P. L., Levy, A. M., Ben-Simchon, L., Haggiag, S., Chebath, J., Revel, M. (2007). Induction of neuronal and myelin-related gene expression by IL-6-receptor/IL-6: a study on embryonic dorsal root ganglia cells and isolated Schwann cells. *Experimental Neurology*, 208(2), 285-296.
- [15] Hama, T., Kushima, Y., Miyamoto, M., Kubota, M., Takei, N., Hatanaka, H. (1991). Interleukin-6 improves the survival of mesencephalic catecholaminergic and septal cholinergic neurons from postnatal, two-week-old rats in cultures. *Neuroscience*, 40, 445-452.
- [16] Alboni, S., Cervia, D., Sugama, S., Conti, B. (2010). Interleukin 18 in the CNS. *Journal of Neuroinflammation*, 29, 7-9.
- [17] Hanisch, U. K., & Quirion, R. (1995). Interleukin-2 as a neuroregulatory cytokine. *Brain Research. Brain Research Reviews*, 21(3), 246-284.
- [18] White, F. A., Sun, J., Waters, S. M., Ma, C., Ren, D., Ripsch, M. (2005). Excitatory monocyte chemoattractant protein-1 signaling is up-regulated in sensory neurons after chronic compression of the dorsal root ganglion. *Proceedings of the National Academy of Sciences of the United States of America*, 102, 14092-14097.
- [19] Sun, J. H., Yang, B., Donnelly, D. F., Ma, C., LaMotte, R. H. (2006). MCP-1 enhances excitability of nociceptive neurons in chronically compressed dorsal root ganglia. *Journal of Neurophysiology*, 96(5), 2189-2199.
- [20] Ubogu, E. E., Cossoy, M. B., Ransohoff, R. M. (2006). The expression and function of chemokines involved in CNS inflammation. *Trends in Pharmacological Sciences*, 27, 48-55.
- [21] Charo, I. F., & Ransohoff, R. M. (2006). The many roles of chemokines and chemokine receptors in inflammation. *New England Journal of Medicine*, 354, 610-621.
- [22] Harrison, J. K., Jang, Y., Chen, S., Xia, Y., Maciejewski, D., McNamara, R. K., et al. (1998). Role for neuronally derived fractalkine in mediating interactions between neurons and CX3CR1-expressing microglia. *Proceedings of the National Academy of Sciences of the United States of America*, 95, 10896-10901.
- [23] Bajetto, A., Bonavia, R., Barbero, S., Piccioli, P., Costa, A. F. T., Schettini, G. (1999). Glial and neuronal cells express functional chemokine receptor CXCR4 and its natural ligand stromal cell-derived factor 1. *Journal of Neurochemistry*, 73, 2348-2357.
- [24] Hall, G. L., Wing, M. G., Compston, D. A., Scolding, N. J. (1997).  $\beta$ -interferon regulates the immunomodulatory activity of neonatal rodent microglia. *Journal of Neuroimmunology*, 72(1), 11-19.
- [25] Boddeke, E. W., Meigel, I., Frentzel, S., Biber, K., Renn, L. Q., Gebicke-Härter, P. (1999). Functional expression of the fractalkine (CX3C) receptor and its regulation by lipopolysaccharide in rat microglia. *European Journal of Pharmacology*, 374, 309-313.
- [26] Baggiolini, M., Dewald, B., Moser, B. (1994). Interleukin-8 and related chemotactic cytokines-CXC and CC chemokines. *Advances in Immunology*, 55, 97-179.
- [27] Cartier, L., Hartley, O., Dubois-Dauphin, M., Krause, K. H. (2005). Chemokine receptors in the central nervous system: role in brain inflammation and neurodegenerative diseases. *Brain Research Reviews*, 48, 16-42.
- [28] Heiman, M. L., Ahima, R. S., Craft, L. S., Schoner, B., Stephens, T. W., Flier, J. S. (1997). Leptin inhibition of the hypothalamic-pituitary-adrenal axis in response to stress. *Endocrinology*, 138, 3859-3863.
- [29] Mabuchi, T., Yatsuya, H., Tamakoshi, K., Otsuka, R., Nagasawa, N., Zhang, H., et al. (2005). Association between serum leptin concentration and white blood cell count in middle-aged Japanese men and women. *Diabetes/Metabolism Research and Reviews*, 21, 441-447.
- [30] Fantuzzi, G., & Faggioni, R. (2000). Leptin in the regulation of immunity, inflammation and hematopoiesis. *Journal of Leukocyte Biology*, 68, 437-446.
- [31] Caldefie-Chezet, F., Poulin, A., Tridon, A., Sion, B., Vasson, M. P. (2001). Leptin: a potential regulator of polymorphonuclear neutrophil bactericidal action. *Journal of Leukocyte Biology*, 69, 414-418.
- [32] Smith, J. B., & Herschman, H. R. (1995). Glucocorticoid-attenuated response genes encode intercellular mediators, including a new C-X-C chemokine. *Journal of Biological Chemistry*, 270, 16756-16765.
- [33] Lyng, K., Munkeby, B. H., Saugstad, O. D., Stray-Pedersen, B., Frøen, J. F. (2005). Effect of interleukin-10 on newborn piglet brain following hypoxia-ischemia and endotoxin-induced inflammation. *Biology of the Neonate*, 87, 207-216.

- [34] Ruohonen, S., Khademi, M., Jagodic, M., Taskinen, H. S., Olsson, T., Røyttä, M. (2005). Cytokine responses during chronic denervation. *Journal of Neuroinflammation*, 18, 2-26.
- [35] Siqueira Mietto, B., Kroner, A., Girolami, E. I., Santos-Nogueira, E., Zhang, J., David, S. (2015). Role of IL-10 in resolution of inflammation and functional recovery after peripheral nerve injury. *Journal of Neuroscience*, 35(50), 16431-16442.
- [36] de Oliveira, C. M., Sakata, R. K., Issy, A. M., Gerola, L. R., Salomão, R. (2011). Cytokines and pain. *Revista Brasileira de Anestesiologia*, 61(2), 255-259. 260-265, 137-142.
- [37] Fregnan, F., Muratori, L., Rodriguez, A. S., Giacobini-Robecchi, M. G., Raimondo, S. (2012). Role of inflammatory cytokines in peripheral nerve injury. *Neural Regeneration Research*, 7, 2259-2266.