Editorial

Int Neurourol J 2020;24(3):189-190
https://doi.org/10.5213/inj.2020edi.005
pISSN 2093-4777 · eISSN 2093-6931

INTERNATIONAL NEUROUROLOGY JOURNAL
INJ
OPEN ACCESS

Future Directions for Neurourological Research

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In the field of neurourolgy, the effects of medications used for therapeutic purposes in lower urinary tract dysfuncion on the micturition center are a long-standing research topic [1]. However, the scope and results of this research have been limited to peripheral target sites such as the bladder, urethra, and prostate. The well-known pharmacological mechanism of mirabegron, a β_3-adrenoceptor agonist that is used as the first-line medication for overactive bladder, is its effect on adrenergic receptors in the bladder body and the urethra. Studies have also suggested a connection between the urothelium and mirabegron's effects [2,3], and it has been hypothesized that β_3-adrenoceptor activation during the bladder filling phase inhibits the secretion of acetylcholine in parasympathetic neurons, which creates a therapeutic effect by reducing micromotions [4]. However, studies reporting that mirabegron increased ^{18}F-fluorodeoxyglucose uptake in the frontal cortex in a dose-dependent manner suggest that the central nervous system, including the brain, may also be involved in the mechanism [5].

In light of these considerations, the review article by Kim et al. [6] published in this issue of *International Neurourology Journal* that presents the currently available information on neural control of the lower urinary tract through recently developed experimental methods will be of great value for our readers.

For example, optogenetics method in biological research involving the combination of optics and genetics in technologies that are designed to control (by eliciting or inhibiting) well-defined events in cells. It is an experimental methodology in neurobiology that genetic and optical methods applied together allow tight spatial and temporal control of the activity of specific kinds of neurons in the living brain. It is a revolutionary advance that will allow us to understand of neural circuit function more precisely. In optogenetics, neurons are genetically engineered to express light-sensitive proteins (chromophore-containing photochemical actuators, such as opsin) firstly. When these neurons are then illuminated with light of the correct frequency they will be transiently activated or inhibited depending on the particular kind of opsin that was chosen for expression. Modulation of the singaling pathway in these neurons is also possible through this method at the single-cell level or at the neuro-circuit level with high accuracy [7,8]. Optogenetics is a new approach that is vastly different from existing methods, with implications for numerous areas of science, ranging from basic science research, brain activity, and behavior to the diagnosis and treatment of disease in neurobiology [9,10].

If optogenetic methods, together with existing urodynamic studies, are applied to the cerebrum, the activity level of neurons in a specified micturition center can be measured. Moreover, how specific neurons relate to lower urinary tract dysfunction can be monitored in real time. By activating or disabling neurons in a specific area, it will be possible to monitor in real time how neurons affect actual voiding dysfunction under specific biological (aging, sleep, while studying) or pathological (spinal cord injury, cerebral injury, degenerative brain disease) conditions. Whether specific treatments influence the activation of neurons and how this influence relates to changes in voiding dysfunction can also be explored.

A detailed understanding of neural control of the lower urinary tract, based on recent academic achievements, is instrumental for the development of disease treatment methods. Therefore, mechanisms with existing evidence should also be re-examined using advanced experimental methods. These ef-

forts will bring about developments in neurourological research and represent a promising research direction that will overcome many obstacles facing current treatment methods.

• **Conflict of Interest:** No potential conflict of interest relevant to this article was reported.

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