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Photo-stimulation using low reactive level laser can improve lower urinary tract dysfunction in 6-hydroxydopamine treated Parkinson disease model

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Background

- Normal micturition reflex, in particular storage reflex, is constructed by spinal reflex via peripheral Aδ-fibre afferent nerves, and which is controlled by central descending inhibitory system.
- On the other hand, abnormal micturition reflexes due to central nervous lesion is constructed by increased spinal reflex via peripheral Aδ- and C- fibre afferent nerves, and which is mainly caused by dis-inhibition of central system.
- This abnormal reflex is well shown in the status of Parkinson disease (PD).
- Photo-stimulation using low reactive level laser is reported to have some neurobiological effects, and which is clinically used to relieve pain in pain clinic.
- As these effects, inhibition of Aδ- and C- fibre nerve conductions in peripheral afferent nerve tract, activation of central descending inhibitory system via peripheral nerve stimulation, and suppression of local synaptic neurotransmission were reported.
- Then, the photo-stimulation may be applicable to modulate central and peripheral neural control of lower urinary tract and normalize abnormal micturition reflex in the status of PD.

Objective

We investigate the photo-stimulating effect of low reactive level laser on neurogenic lower urinary tract dysfunction (LUTD) in PD model.

Subjects and Methods

Experiments were performed on the adult male Sprague-Dawley rats (11-13 weeks old, weighing 250-350g) in standardized environmental conditions. The experimental protocol was approved by the Animal Ethics Committee, Chiba University Graduate School of Medicine.

Surgical Preparation (PD model)

Four weeks before studies, bilateral injections to substantia nigra of 6OHDA (PD model) were performed stereotaxically.

Urodynamic Evaluation

Under urethane anaesthesia (1.2-1.5 mg/kg s.q. + i.p.), a polyethylene catheter (PE-50) was inserted into the bladder from the bladder dome with midline abdominal incision.

After the operation, animal was placed on a hand made mesh table for urodynamic study. Urodynamic investigation was performed under remaining anaesthesia. ***Interval time between voids***, ***urine volume per void***, and ***maximum bladder pressure during voiding*** were investigated under continuous saline infusion cystometry (0.04-0.2ml/min).

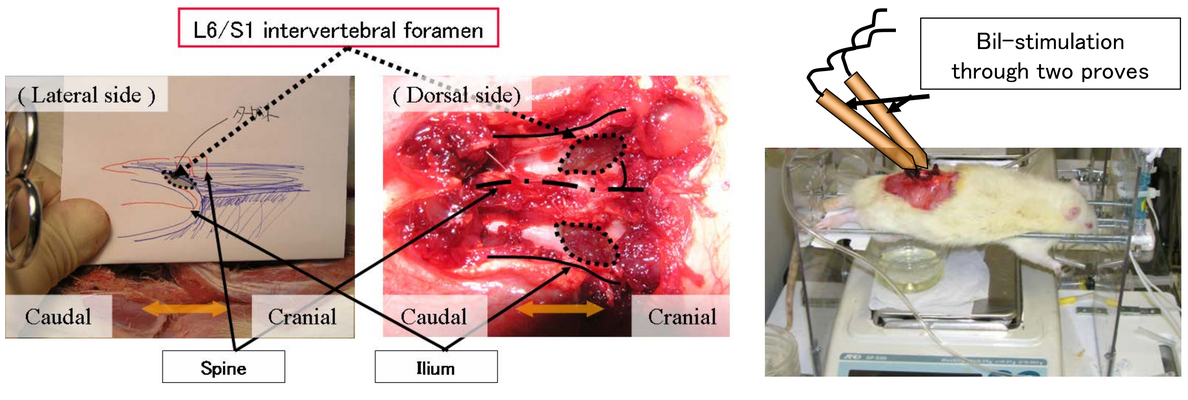
General Protocol

After the achievement of reproducible micturition cycle and 30-60 minutes' baseline recording, sham stimulation and stepped up photo-stimulation using low reactive level laser via the prove was irradiated to bilateral L6/S1 intervertebral foramen transcutaneously via the probe contacted to body. Recording after the stimulation was continued until micturition cycle returned to baseline.

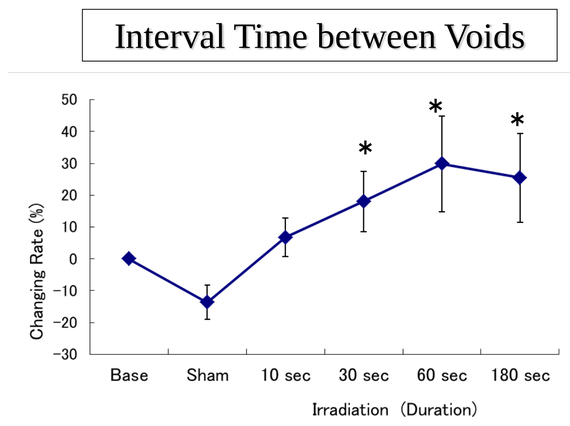
Photo-Stimulation Protocol

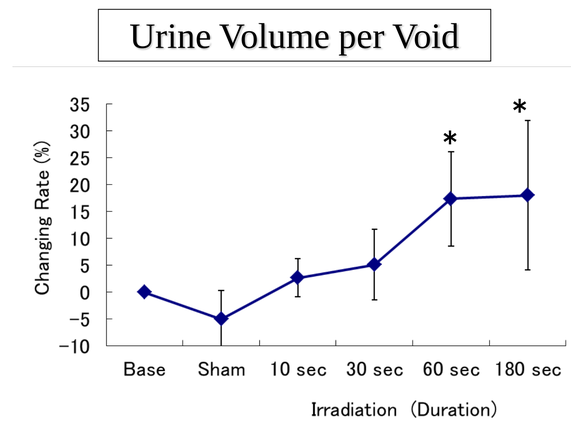
Photo-stimulation is operated by the gallium-aluminum-arsenide (Ga-Al-As, wavelength 810 nm) diode laser device. The output power used was 180 mW and the durations of irradiation were 10 sec, 30 sec, 60 sec and 180 sec.

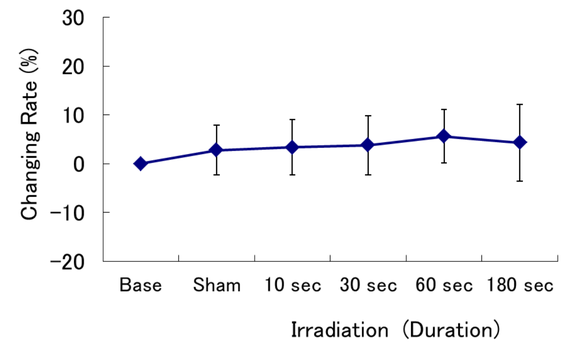
Figure 1. Exposed L6/S1 intervertebral foramen in Rat
(Actual stimulation was transcutaneusly irradiated in this study)



Results







＊: vs Sham-stimulation, P<0.01

- In PD mode, interval time between voids and urine volume per void decreased generally. Compared with the baseline record, in sham-stimulated groups, interval time between voids and urine volume per void were not changed. In photo-stimulated groups, interval time between voids and urine volume per void was tend to be increased. These changes were stimulation-time dependent. And in any groups, maximum bladder pressure in voiding phase was unchanged.

Interpretation of Results

- For neurogenic LUTD of PD model,
  - photo-stimulation using low reactive level laser to bilateral L6/S1 intervertebral foramen inhibited abnormal micturition reflex during filling
  - voiding function, bladder contraction during voiding, was not affected by this photo-stimulation.

Discussion

•As well as anti-nociceptive mechanisms, photo-stimulation with low reactive level laser to bilateral L6/S1 intervertebral foramen is thought to have some effects on parts of micturition reflex arc; 1) inhibition of Aδ-/C- fiber nerve signals from the bladder (mainly due to depolarizing block), 2) inhibition of neuronal discharge in L6 dorsal root ganglion, and 3) activation of spinal or supra-spinal descending inhibitory system to lumbosacral micturition centre, and may inhibit storage reflex.

•On the other hand, photo-stimulation with low reactive level laser is reported to have no effect on efferent nerve condition and motor function generally.

•Our preliminary study show photo-stimulation with low reactive level laser to bilateral parts of micturition reflex arc modulated storage function but not voiding function in normal rats. (presented in International Society for Autonomic Neuroscience (ISAN) meeting 2009)

•Our results in this study suggest that this photo-stimulation can modulate not only normal micturition reflex but also abnormal micturition reflex in PD, and that it can operate storage disorder both with and without voiding disorder in PD.

Conclusion

- Photo-stimulation using low reactive level laser to bilateral L6/S1 root can improve storage disorder by abnormal micturition reflex without exacerbation of voiding disorder in LUTD of PD model.
- This new device may be useful for the treatment of LUTD in PD.

Reference

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