Chronic bladder control post SCI via Electric Pudendal Nerve Block

Manfred Franke, Narendra Bhadra, Niloy Bhadra, Kevin L. Kilgore, and Kenneth J. Gustafson

FOLLOWING spinal cord injury (SCI), external urethral sphincter (EUS) spasms can prevent successful bladder emptying and result in medical complications. High Frequency Alternating Current in the kilohertz range (KHFAC) can be used to electrically block action potential propagation in the pudendal nerve (PN), which innervates EUS [1]. KHFAC PN block reduced EUS pressures and produced complete bladder voiding in a previous acute study [2]. The purpose of the present study was to produce electric PN block and restore voiding function in awake animals following chronic-SCI.

I. Methods

Tripolar spiral electrodes were implanted bilaterally on the PN and the extradural sacral roots innervating the bladder, in five animals. Stable bladder drive was acquired in three animals which were voided electronically under anesthesia. Animals underwent complete SCI at Th10-12. EUS reflexes limited voiding after SCI. Animals were maintained with manual expression. Awake electric-only bladder maintenance began after spinal reflexes stabilized 4-5 weeks post SCI. Bladder pressure was produced using either continuous or intermittent (2s on, 4s off) sacral root stimulation, with or without KHFAC PN block.

II. Results

Bilateral KHFAC PN block was achieved in each test for up to 125 days from first test to terminal (140 days post implant) and led to a reduction of sacrally evoked EUS pressure of 80.8±22.1%. KHFAC improved voiding using both, continuous (6.8±3.5% to 89.2±10.2%, $p<0.0001$) and intermittent (33.7±18.0% to 90.8±8.1%, $p<0.0001$) sacral drive. KHFAC voiding percentages were greater than with manual bladder expression (75.1±17.1%, $p<0.0001$). KHFAC aided voiding replaced manual expression in three animals for bladder emptying for 7, 22 and 44 weekdays. Voiding volumes with KHFAC block were equivalent to volumes achieved with transected pudendal nerves.

In this study we also showed the necessity of ensuring the absence of DC-contamination in the applied KHFAC waveforms, especially in chronic applications of electric nerve block. Stability of PN conductivity and activation thresholds, and evoked EUS pressures was only achieved when DC-free KHFAC waveforms were used for daily bladder voiding. Inspection of electrodes and PN post mortem showed the absence of nerve discoloration and damage to the electrode which had been observed in preliminary studies prior to the elimination of DC-contamination in the KHFAC waveform.

III. Conclusion

KHFAC PN block can restore voiding function after chronic-SCI. These results support continued development of neural prostheses using electrical nerve block for voiding dysfunction.

References

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Manfred Franke is with Case Western Reserve University, Cleveland, OH, 44106 USA (216-586-4446; e-mail: Manfred.Franke@gmail.com).

Narendra Bhadra is with the Department of Veteran's Affairs Louis Stokes Veterans Administrations Medical Center and Case Western Reserve University, Cleveland, OH, 44106 USA (e-mail: nxb11@case.edu).

Niloy Bhadra is with Metro Health Hospitals and Case Western Reserve University, Cleveland, OH, 44106 USA (e-mail: nxb26@case.edu).

Kevin L. Kilgore is with the Department of Veteran's Affairs Hospital, Metro Health Hospitals and Case Western Reserve University, Cleveland, OH, 44106 USA, (e-mail: klk4@case.edu).

Kenneth J. Gustafson is with the Department of Veteran's Affairs Medical Center and Case Western Reserve University, Cleveland, OH, 44106 USA, (corresponding author to provide phone: 216-368-8626; e-mail: kjg@case.edu).