

THE EFFECTS OF PUDENDAL NERVE STIMULATION WITH DIFFERENT FREQUENCY ON BLADDER DYSFUNCTION IN SPINAL CORD INJURY DOGS AT DIFFERENT STAGES

Hypothesis / aims of study

The previous studies have shown that electrical stimulation of the pudendal nerve at different frequencies using an implanted cuff electrode could either inhibit or excite the bladder in chronic spinal cord injured (SCI) cat^[1]. The goal of current study was to further investigate the two questions: 1) whether there is a difference between the effects of electrical stimulation of pudendal nerve at 5Hz on bladder function in dogs with SCI when it is administered early (1 month) or late (6 months) after SCI; 2) Whether voiding efficiency during voiding induced by pudendal nerve stimulation at 20Hz is higher than which during voiding induced by bladder distension without stimulation in dogs with SCI.

Study design, materials and methods

The study was done in 8 dogs which chronic spinal cord transection at T9-T10 level.

1) The 8 dogs were randomly allocated into 2 groups including Group 1 (4 dogs) that underwent spinal cord transection followed by electrical stimulation of pudendal nerve at 5Hz 1 month after transection, when spinal micturition reflexes in response to bladder distension were prominent; group 2 (4 dogs) that underwent spinal cord transection followed by electrical stimulation of pudendal nerve 6 months after transection. The stimulation was conducted with slow infusion into the bladder which was always started from the bladder empty. When fluid was released from bladder, the infusion and stimulation were stopped immediately.

2) In group 1, we also calculated the voiding efficiency respectively when bladder voiding reflex was induced by bladder distension or pudendal nerve stimulation at 20Hz with Slow infusion into the bladder. Residual volume was measured by suction the catheter with a syringe after voiding

Results

1) In the first experiment (fig.1), the bladder capacity increased significantly ($p < 0.05$) by pudendal nerve stimulation at 5Hz in group 1, but there were no significant effect on capacity ($p > 0.05$) in group 2.

2) In the second experiment, pudendal nerve stimulation can induce a post-stimulation voiding. The voiding efficiency in this situation was significantly ($p < 0.05$) higher than which was induced by bladder distension (table.1) .

Interpretation of results

In this study, we found electrical stimulation of the pudendal nerve at 5 Hz could not increase bladder capacity in group 2. We postulated that this might be due to irreversible histological changes in the detrusor wall. The 4 dogs in this group were all underwent electrical stimulation when 6 months after SCI. In this six months, we did not give them any treatments on neurogenic bladder dysfunction after spinal micturition reflexes in response to bladder distension were prominent. We examined the differences between two groups of bladder wall histology and found that collagen increased and elastin decreased significantly in group 2 compared with group 1. These changes led to bladder fibrosis. So electrical stimulation of the pudendal nerve can only increase bladder capacity in group 1 in which the 4 dogs are 1 months after SCI.

Electrical stimulation of the pudendal nerve at 20 Hz applied at the end of the CMG can induced a large amplitude, long-lasting bladder contraction. However, voiding only occurred after the stimulation was terminated (i.e., post-stimulus voiding) because the external urethral sphincter, which is innervated by the pudendal nerve, was also activated during the 20-Hz stimulation. When the stimulation was stopped, the external urethral sphincter (striated muscle) relaxed faster than the detrusor (smooth muscle) allowing bladder pressure to exceed urethral pressure, and thereby inducing post-stimulus voiding. Though the voiding efficiency in this situation was significantly higher than which was induced by bladder distension, it was also low.

In our experiment, we found another interesting phenomenon. When we put another cuff electrode at proximal pudendal nerve and give a high-frequency stimulation at 10KHZ, 20-HZ stimulation did not induce bladder contraction (fig.2). This was consistent with previous study that high-frequency can block nerve conduction in simulation research^[2]. Thus we assume high-frequency stimulation can block the conduction of impulses to the sphincter if we put a high-frequency stimulation electrode at distal pudendal nerve. If this is confirmed, urination will be similar to normal and voiding efficiency can be increased.

Concluding message

This study shows that pudendal nerve stimulation at 5HZ can only increase the bladder capacity in early period after SCI before bladder wall fibrosis. And in this period 20-HZ pudendal nerve stimulation can elicit bladder contraction and increase voiding efficacy .Therefore, we believe that pudendal nerve stimulation should be used to treat NDO secondary to SCI earlier after the other conservative treatments have no effects.

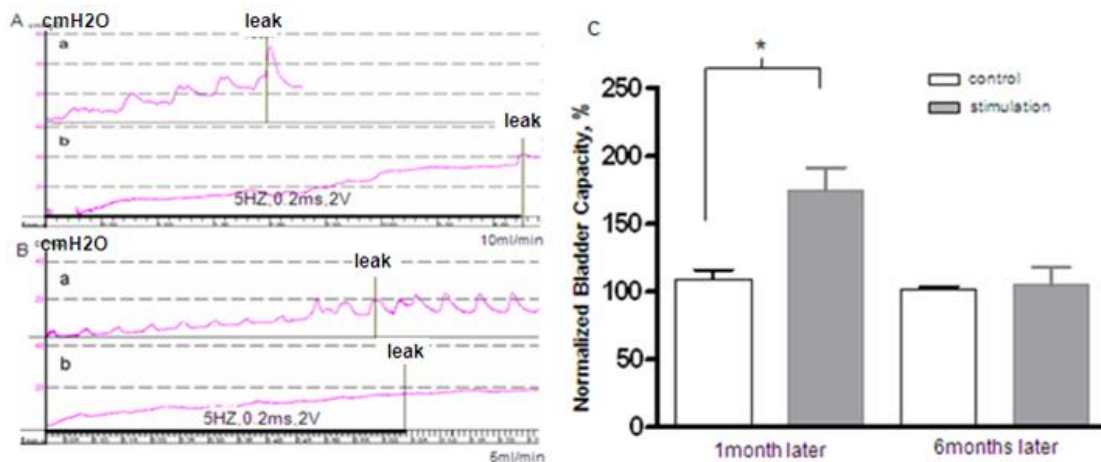


Fig1: In group 1(A -1 month post SCI), pudendal nerve stimulation at 5Hz (b) can increase the capacity significantly compared to baseline(a). In group 2(B - 6months post SCI), pudendal nerve stimulation at 5Hz (b) can not increase capacity compared to baseline (a). C was the summary of the changes of capacity.

Table.1 The voiding efficiency with or without pudendal nerve stimulation at 20Hz

	Dog#1	Dog#2	Dog#3	Dog#4
SCI without stimulation	7%	5%	6%	5%
SCI with stimulation	15%	14%	16%	20%

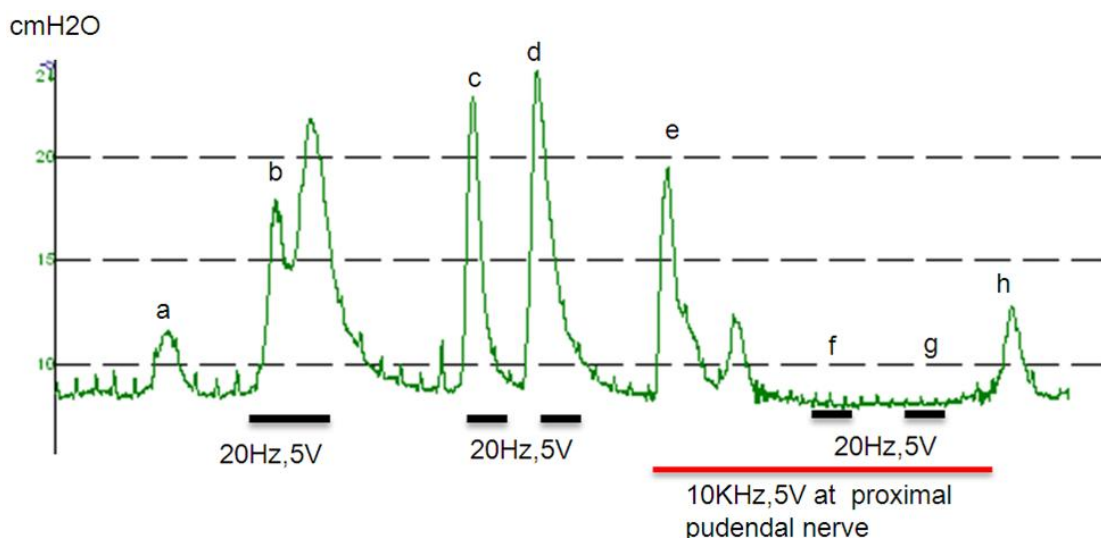


Fig.2: a and h were induced by bladder distension. Pudendal nerve stimulation at 5Hz can induce a stronger bladder contraction (b、c、d). 10-KHz stimulation can firstly induce a contraction (e), then stimulation at 20Hz was blocked(f、g).

References

1. Tai C, Wang J, Wang X, de Groat WC, Roppolo JR. Bladder inhibition or voiding induced by pudendal nerve stimulation in chronic spinal cord injured cats. *Neurourol Urodyn.* 2007;26(4):570-7.

Disclosures

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