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Electroacupuncture improves voiding function in patients with neurogenic urinary retention secondary to cauda equina injury: results from a prospective observational study

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Abstract

Objective To report the therapeutic effectiveness and feasibility of electroacupuncture (EA) treatment in patients with urinary retention which is caused by cauda equina injury and refractory to conventional conservative treatments.

Methods From 9 August 2007 to 10 May 2010 prospective evaluation was carried out in 15 patients with neurogenic urinary retention secondary to cauda equina injury who underwent EA treatment at bilateral points BL32, BL33 and BL35. All patients received five sessions of EA treatment each week for the first 4 weeks, three sessions a week for the following 2 weeks, and then were followed up for 6 months. Voiding abilities, postvoiding residual urine volume (RUV) and maximum urinary flow rate (Qmax) were documented as outcome measures.

Results After 6 weeks' EA treatment, 10/15 enrolled patients regained their self-voiding ability, and the mean postvoiding RUV for all patients decreased by 303.6±148.8 ml. In nine patients with documented data, Qmax increased by 11.0±6.3 ml/s. In nine patients, voiding difficulties changed from severe to mild. At the end of 6 months' follow-up, 8/10 patients retained their regained self-voiding ability, whereas two patients had lost their voiding ability again.

Conclusion The results indicate that the EA treatment may have longlasting therapeutic effectiveness in the management of neurogenic urinary retention secondary to cauda equina injury.

INTRODUCTION

Neurogenic urinary retention can be caused by various diseases and events that affect the nervous systems controlling the lower urinary tract—for example, neural tube defects,[1 2] trauma[3] and iatrogenic factors.[4 5] Patients with neurogenic urinary retention usually require lifelong continuous or intermittent catheterisation[6] and may have irreversible renal damage and bladder-wall destruction.[7] Urinary retention significantly affects patients' overall health and has devastating negative effects on patients' quality of life.[8 9] Effective treatment of neurogenic urinary retention comprises successfully decreasing intravesical pressure and alleviating lower urinary tract symptoms; in this way, vesicoureteral reflux and possible renal damage can be prevented. As advances have been made in the field of medicine, possible treatments range from non-invasive (ie, assisted bladder emptying and rehabilitation manoeuvres, antimuscarinic agents) to minimally invasive (ie, catheterisation, intravesical electrostimulation) to surgical procedures (ie, detrusor myectomy, neuromodulation).[10] Among these treatment modalities, sacral neuromodulation, a surgical technique for electric stimulation, has been popularised and shown to be effective for the management of lower urinary tract symptoms; and a considerable number of reports have been published.[11] Nevertheless, chronic urinary retention, especially when it is caused by neurogenic factors, cannot be effectively cured.

Acupuncture, a major component of traditional Chinese medicine, has been used in China for thousands of years for various lower urinary tract symptoms. Many acupuncture/electroacupuncture (EA) clinical trials have been carried out in China and the rest of the world; their results suggest a clinical role of acupuncture for lower urinary tract dysfunctions caused by spinal cord injury.[12–15] Furthermore, EA treatment in acute spinal cord injury may significantly improve long-term neurological recovery of bladder functions.[16] However, owing to the complex acupoint selection and laborious acupuncture treatment protocol, together with a lack of standardised therapeutic evaluation, the effects of acupuncture treatment for neurogenic bladder dysfunction are seldom recognised and accepted.[12] As EA treatment has become more popular all over the world and as similarities between EA treatment at the sacral region and sacral neuromodulation exist, we aimed to evaluate the therapeutic effectiveness and feasibility of EA treatment at BL32, BL33 and BL35 in patients with urinary retention which is caused by cauda equina injury and is refractory to conventional conservative treatments.

MATERIAL AND METHODS

Study design and setting

This was a prospective case series study performed at the department of acupuncture at Guang'an Men Hospital, one of the largest tertiary-level teaching hospitals for traditional Chinese medicine in China. The hospital ethics committee approved this treatment protocol for patients with chronic urinary retention of cauda equina injury, and each patient signed informed consent before study participation. EA treatment at the level of S2 and S3 were implemented by two senior acupuncturists with more than 20 years' clinical experience in acupuncture practice. Data management and assessment of therapeutic effectiveness were performed by different graduates who were blinded to the treatment procedures. Acupoints of BL32 and BL33 were selected and localised as detailed in the following section, and bilateral acupoints of BL35 were chosen according to WHO standardised acupuncture point location.[16]

Treatment protocol

All patients received EA treatment for five sessions a week for the first 4 weeks, three sessions a week for the following 2 weeks and then were followed up for 6 months. For the EA treatments, Huatuo brand needles (size 0.35 mm × 13 mm, manufactured by Suzhou Medical Appliance, Suzhou, Jiangsu Province, China) together with G6805 Electro-Acu Stimulators (Huayi Medical Supply & Equipment Co, Ltd, Shanghai, China) were used. In order to localise BL32 and BL33 accurately, we first drew a line between the two posterior superior iliac spines (PSIS) which cross over at point A of the spinal column, then, drew two lines connecting each PSIS and point A, respectively, and finally, used these two lines to form two equilateral triangles inferiorly. The imaginary apexes B and C of these two equilateral triangles are the two BL33 acupoints. The acupuncturists inserted the needle obliquely at an angle of about 30 degrees for about 12 cm until the patient felt heaviness and numbness locally or even a shooting sensation along to the genitalia. Needle insertions at the two BL32 acupoints, which are located a distance of one patient finger superior to BL33, were carried out in the same way as those of BL33, and needle insertion at BL35 was performed perpendicularly at a depth of around 8 cm (figure1). Paired alligator clips with negative and positive electrodes of the EA apparatus were attached to the needle holders at each pair of acupoints. Finally, the intensity of stimulus of BL32 or BL33 points was gradually increased until plantar flexion of the entire foot or internal rotation of both hips was noticed or shooting sensations were again felt by the patient. The intensity of stimulus of the remaining pairs was modulated to be well-tolerated by the patient. Electrical frequency was set at 20 Hz and the duration of treatment (needle retention) at each visit was 50 min.

Patient selection and evaluation

For inclusion, the following criteria had to be fulfilled by the patients: (1) clinically diagnosed with chronic urinary retention; (2) with a disease course of ≥3 months; (3) refractory to conservative treatments (ie, assisted bladder emptying and rehabilitation manoeuvres and antimuscarinic agents) and require catheterisation; (4) urinary retention secondary to cauda equina injury.

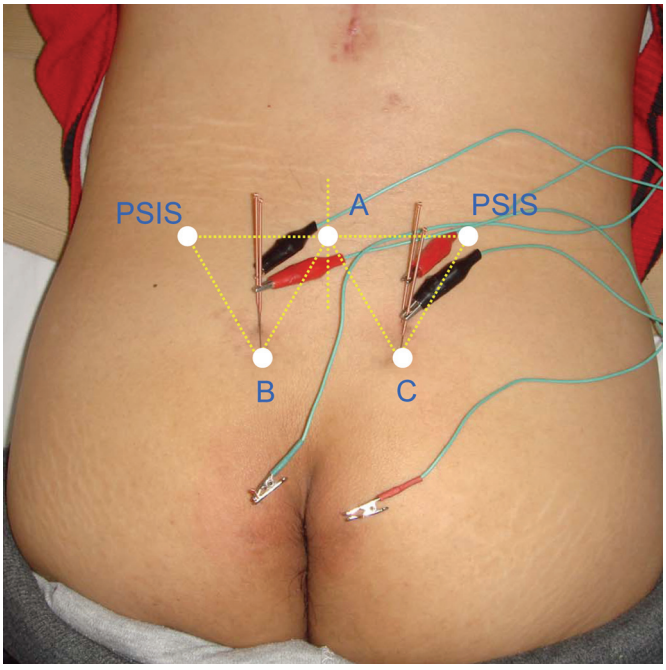

Figure 1 A patient being treated with electroacupuncture for neurogenic urinary retention. PSIS, posterior superior iliac spine; (A) crossing point of spinal column and the line connecting the two posterior superior iliac spines; (B) and (C) acupoints BL33.

From 9 August 2007 to 10 May 2010, a total of 55 patients with voiding difficulties visited the outpatient department of acupuncture at Guang An Men Hospital. All patients were admitted for a 1-week baseline evaluation of voiding behaviour. The self-voiding ability, amount of postvoiding residual urine volume (RUV) and maximum urinary flow rate (Qmax) were recorded by our research staff in a voiding diary from the start of the patient's visit. Forty patients were excluded from study for the following reasons: seven had a disease course of <3 months; 14 did not require catheterisation; 16 had neurogenic urinary retention not caused by cauda equina injury. In addition, another three were excluded from the final assessment of efficacy because they had received this acupuncture treatment for <6 weeks.

Only 15 patients (11 male, 4 female, aged 7–75 (mean±SD 45.9±17.9) years) met the inclusion criteria and the efficacy of EA was assessed in these patients. Assessment of the aetiology was carried out before assessment of efficacy: five had received operations for lumbar protrusion or spinal stenosis; three had had surgery for a tethered spinal cord; two had received an injection at the spinal canal for anaesthesia; two had been injured in the lumbar region in motor vehicle accidents; one had had spina bifida surgery; one had traumatized lumbar spine; and one had had an operation for myelomeningocele. Owing to these causes and the symptoms which developed, all 15 patients

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were diagnosed with cauda equina injury in a tertiary-level Western hospital in China and all were refractory to conventional conservative treatments.

Patients' voiding diaries, postvoiding RUV and Qmax were used to quantify the efficacy of EA treatment on urinary retention and were the primary outcome measures of the study. Assessment of the efficacy of EA treatment was based on comparison of independent voiding ability (including catheterisation and voiding difficulty), postvoiding RUV and Qmax at baseline and after 6 weeks of EA treatment. In addition, patients' self-voiding abilities were further evaluated at the end of 6 months' follow-up.

Statistical analysis

Statistical analysis was performed with the SPSS software package (version 17.0) for Windows XP. Quantitative data of postvoiding RUV and Qmax were expressed as mean±SD. A paired samples t test was used to measure the difference between baseline values and values after treatment.

RESULTS

As shown in supplementary table 1, before the study, all 15 patients required catheterisation and had no self-voiding ability; 11 patients had self-reported severe voiding difficulty; five patients had stool retention at the same time; seven patients voided with abdominal straining (Valsalva manoeuvre). After 6 weeks' treatment, 10/15 patients resumed their self-voiding ability and were catheter free; in 11 patients with self-reported severe voiding difficulty, nine had self-reported mild difficulty (9/11, 81.8%), two had medium difficulty (2/11, 18.2%); 3/5 patients (60%) with stool retention resumed their bowel movements and were able to defecate; 4/7 patients (57.1%) no longer required abdominal straining to help urination.

At the end of treatment, the mean postvoiding residual urine volume for these 15 patients decreased from 361.3±154.2 ml at baseline to 57.7±47.7 ml—a difference of 303.6±148.8 ml. The paired samples t test showed a t value of 7.90 with p value of 0.000, showing significant improvement in postvoiding RUV. Qmax data were available for nine patients and showed an increase from 4.2±3.2 ml/s to 15.2±7.4 ml/s—a difference of 11.0±6.3 ml/s. The paired samples t test showed a t value of 5.21 and a p value of 0.001, indicating a statistically significant increase in Qmax (table 1).

At the end of the 6 months' follow-up, 8/10 patients who had self-voiding ability and were catheter free after treatment retained their self-voiding function and did not require catheterisation, and have mild difficulty voiding. The other two, however, lost their self-voiding ability, had medium difficulty voiding, and were catheterised. No other changes were found at the end of the 6 months' follow-up.

DISCUSSION

In clinical practice, uroflowmetry (plotting of flow rate with time) has been found to have reasonable sensitivity and specificity if carried out correctly. Free uroflowmetry (especially, Qmax) and assessment of RUV using ultrasound provide the first details of the voiding function of patients.[17] They are easy non-invasive tests that reflect bladder function in a timely manner.[18] In our study, 10/15 patients regained their self-voiding ability after treatment and marked improvements were found in patients' self-reported voiding difficulties. After treatment postvoiding RUV fell by 303.6±148.8 ml and Qmax increased by 11.0±6.3 ml/s. Furthermore, during the follow-up, only two of the 10 patients who regained their self-voiding ability with treatment required catheterisation again.

These results agree with those obtained by Yi *et al*,[19] who used electroacupuncture to improve urinary bladder function after radical hysterectomy; confirm the results in a neurogenic bladder case study (multiple sclerosis) by Hesselink and Kopsky[20]; and add further evidence to the review by Thomas *et al*,[21] in which the authors proposed that acupuncture may be helpful in the management of urinary incontinence after stroke. Although patients' specific disorders in these studies differ from this study, all their patients had lost a certain degree of neural control of the urinary bladder. Therefore, we hypothesise that EA may have modulation effects on the nervous system controlling urination. Additionally, various positive results of acupuncture treatments for spinal cord injury-induced neurogenic lower urinary tract dysfunction have been documented in Chinese journal articles.[12] This study shares similarities with these Chinese studies in its patient population, but differs slightly from the former studies in specific acupoint selection. However, BL32 and BL33 are mostly used in these studies, which may indicate that BL32 and BL33 have neuromodulatory effects on the nervous system controlling the urinary bladder.

Interestingly, we also noticed that with EA treatment, three out of five patients (3/5, 60%) resumed their bowel movements and were able to defecate. These effects may be associated with the location of BL32, BL33 and BL35 (especially BL35, which is located near the anus) and the

Table 1 Quantitative items assessed before and after electroacupuncture treatment ($\bar{x} \pm s$)

No.	Item Assessed	Baseline	After Treatment	Difference	t	p Value
15	RUV	361.3±154.2	57.7±47.7	303.6± 148.8	7.90	0.000
9	Qmax	4.2±3.2	15.2±7.4	11.0±6.3	5.21	0.001

Note: Qmax= maximum urinary flow rate, RUV= post-voiding residual urine volume, Unit for Qmax is ml/s, Unit for RUV is ml.

EA stimulation, because sacral neuromodulation studies in the same region have demonstrated therapeutic effectiveness in the management of neurogenic faecal incontinence.[22 23] EA treatment at BL32 and BL33 are known to be partially electric stimulation of the S2 and S3 sacral nerve roots, and according to anatomical knowledge, EA at BL35 stimulates the inferior rectal nerve, a terminal branch of the motor division of the pudendal nerve. All these aforementioned nerve structures are important for the control of both bowel movements and urination. Therefore, EA treatment at BL32, BL33 and BL35 may modulate the autonomous nervous system at the sacral region, which controls both bowel movements and urination.

Although the exact mechanism of EA treatment has not yet been clarified, researchers believe that the effects of sacral neuromodulation occur at the spinal and supraspinal level by the inhibition of spinal tract neurons involved in the micturition reflex and interneurons involved in spinal segmental reflexes and postganglionic neurons.[24] Acupuncture stimulation to the sacral segment reportedly increases bladder capacity, suppresses the overactive bladder,[25–27] invigorates GABAergic systems suppressing the activity of noradrenergic locus coeruleus neurons,[28] and inhibits capsaicin-sensitive C-fibre activation.[29] In our study, given the fact that voiding ability was regained in patients with neurogenic urinary retention and that the therapeutic effectiveness generally continues for 6 months' follow-up, EA at the sacral level may stimulate the parasympathetic centre at the S2–S4 level and invigorate the acetylcholinergic fibres innervating the bladder and therefore improving the balance of bladder function; however, further basic research is needed to explore these molecular level changes.

EA treatment is a combination of electric stimulation and acupuncture modulation; neuromodulation is a technology that acts directly upon the nerves, altering or modulating nerve activity by delivering electrical or pharmaceutical agents directly to a target area[30]; therefore, we believe that the EA treatment in this study works in the same way as neuromodulation and can be categorised in the field of sacral neuromodulation. Sacral neuromodulation, which is conventionally done with surgery, has been shown to be effective in the management of both urinary and faecal incontinence by various researchers,[11 21 22] and this intervention has become increasingly popular throughout the world in the past more than 10 years.[11]

The conventional type of sacral neuromodulation itself has a number of limitations.[31] It is an expensive invasive surgical procedure, and requires a temporary lead for test stimulation before a permanent implant. Furthermore, possible complications, such as electrode migration, may impede its use and therapeutic effectiveness. EA at the sacral segment, however, as shown in our study, deals with most of the above-mentioned problems with no or only a few side effects for patients with neurogenic urinary retention, and this technique can be used for studies of intermittent neuromodulation.

However, this EA study is a non-randomised and uncontrolled trial with a relatively small sample population; therefore, the results of this study may not characterise the general response of patients to EA treatment.

CONCLUSION

In this small, prospective observational study, EA treatment at bilateral points of BL32, BL33 and BL35 improved self-voiding ability in a group of patients with neurogenic urinary retention in whom conventional conservative treatments had failed. EA treatment at the sacral region offered an easily manageable intermittent neuromodulation for patients with neurogenic urinary retention, with no or only a few side effects. However, this study is a non-randomised and uncontrolled trial with a relatively small sample population; therefore, the results of this study may not characterise the general response of patients to EA treatment. In order to further clarify the therapeutic effectiveness and durability of this EA treatment at the sacral region for neurogenic urinary retention, further studies with a randomised control design are warranted.

Summary points

- Neurogenic urinary retention is disabling and difficult to treat
- We studied patients with chronic symptoms from cauda equina injury
- EA stimulation was given to sacral segments
- EA was associated with favourable outcomes in ten of fifteen selected patients

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Competing interests None.

Patient consent Obtained.

Ethics approval This study was conducted with the approval of the ethics committee of Guang An Men Hospital.

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