BMJ Open

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Journal:	*BMJ Open*
Manuscript ID	bmjopen-2022-062323
Article Type:	Protocol
Date Submitted by the Author:	26-Feb-2022
Complete List of Authors:	Chen, Shan; Zhejiang Hospital of Traditional Chinese Medicine, Department of Acupuncture and Moxibustion Wang, Siyou; Shanghai Yueyang Hospital, Clinical Research Section, Shanghai Research Institute of Acupuncture and Meridian Liu, Shan; Zhejiang Hospital of Traditional Chinese Medicine, Clinical Evaluation and Analysis Center Wang, Shenhong; Zhejiang Hospital of Traditional Chinese Medicine, Department of Urology Xuan, Lihua; Zhejiang Hospital of Traditional Chinese Medicine, Department of Acupuncture and Moxibustion Gao, Yunqiu; Zhejiang Hospital of Traditional Chinese Medicine, Department of Urology
Keywords:	Urinary incontinences < UROLOGY, Prostate disease < UROLOGY, UROLOGY

Efficacy of electrical pudendal nerve stimulation versus pelvic floor muscle training in treating post-radical prostatectomy urinary incontinence: study protocol for a randomised controlled trial

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Word count: 3588

ABSTRACT

Introduction: Urinary incontinence (UI) is one of the main complications of radical prostatectomy. Electrical pudendal nerve stimulation (EPNS) has been used to treat stress UI based on its mechanism of passive pelvic floor muscle contraction reported in previous research. However, there are no studies comparing the effects of EPNS and active pelvic floor muscle training (PFMT) in the treatment of post-radical prostatectomy UI (PPUI). Here, we describe the protocol for a randomized controlled trial to evaluate the efficacy of EPNS in treating PPUI compared with PFMT.

Methods and analysis: This study is designed as an open-label randomized controlled trial with blinded assessment and analysis. A total of 90 eligible men will be randomly allocated to two groups. The treatment group (n = 45) will receive EPNS while the control group will perform PFMT by doing the Kegel exercise. Forty EPNS treatment sessions will occur over a period of 8 weeks. The primary outcome measure will be improvement rate, and the secondary outcome measures, the number of pads used, 24-hour pad test, and International Consultation on Incontinence Questionnaire-Urinary Incontinence Short Form (ICIQ-UI SF) will be compared between baseline and the study endpoint.

Ethics and dissemination: This protocol has been approved by the Ethics Committee of the First Affiliated Hospital of Zhejiang Chinese Medical University (approval no. 2021-KL-040-02). Written informed consent will be obtained from each participant. The results of the study will be published in peer-reviewed journals.

Trial registration number: ChiCTR2200055461

Strengths and limitations of this study

- This trial will be the first to compare the clinical efficacies of EPNS and PFMT in the treatment of PPUI.
- Our protocol ensures that changes in the amount of urine leakage will be recorded accurately.
- All patients will be followed-up at 6 months after the completion of treatment

for the observation of the long-term efficacy of EPNS.

- Owing to the nature of acupuncture, acupuncturists and participants will not be blinded.
- Non-adherence to PFMT may potentially affect the treatment efficacy in the control group; therefore, we will employ dedicated personnel who will help participants complete the PFMT training.

INTRODUCTION

Urinary incontinence (UI) is one of the main complications of radical prostatectomy (RP). The incidence of post-radical prostatectomy UI (PPUI) ranges from 5% to 70%, [1] with the incidence of UI at 12 months postoperatively exceeding 20%.[2,3] Besides posing a heavy economic burden, UI also has a considerable negative impact on the social life and interpersonal relationships of patients.[3,4] Stress urinary incontinence (SUI) is the main type of PPUI;[5] however, there are currently no recommended pharmacological agents for the non-surgical treatment of PPUI.[6]At present, pelvic floor muscle training (PFMT) is the most widely used approach for treating PPUI.[6,7] Although PFMT enables the strengthening of pelvic floor muscles,[8] many patients find it difficult to perform the training correctly. In addition, the relatively long treatment duration makes it difficult for patients to persist with PFMT in the long term, ultimately resulting in poor treatment adherence.[9] Transanal electrical stimulation is a non-invasive, passive method of pelvic floor muscle training that enhances patient adherence.[10] However, its effects are indirect in nature owing to the use of surface electrodes. A study comparing the effects of PFMT alone and in combination with transanal electrical stimulation for the treatment of PPUI reported that although both regimens improved UI, the difference in their effects was not statistically significant.[10,11]

Electrical pudendal nerve stimulation (EPNS) is a novel technique for the treatment of SUI. In previous studies, we used computed tomography in the transverse plane with simultaneous pelvic floor measurements to demonstrate that EPNS enabled pelvic floor muscle contraction and was effective in treating female SUI and urge incontinence.[12-14] In a recent study, we used simultaneous measurements of movement and surface electromyography of the pelvic floor muscles in male subjects to show that EPNS promoted the contraction and strengthening of pelvic floor muscles and the simulation of PFMT, thus leading to the effective treatment of PPUI.[15] Compared with active PFMT, EPNS can provide highly effective passive training for the pelvic floor muscles. This can help address the difficulties faced by patients in correctly locating the pelvic floor muscles and persisting with PFMT, thus improving overall patient adherence.

However, across studies, there are significant differences in the indicators and assessment techniques for determining the degree of UI, and the long-term efficacy of EPNS for treating PPUI has not been reported. In addition, although it is known that EPNS can simulate PFMT, there are no studies comparing the effects of EPNS and PFMT in the treatment of PPUI.

Objective

This trial aims to evaluate the long-term efficacy of EPNS in treating PPUI through the establishment of a PFMT control group and adoption of comprehensive assessment criteria and indicators.

METHODS AND ANALYSIS

Study design

This trial will compare the efficacy of EPNS with that of PFMT for the treatment of PPUI. It will be designed as a blind randomised study, and data will be analysed for two parallel groups over an 8-week treatment period. Ninety participants with PPUI will be randomly assigned to the treatment and control groups at a 1:1 ratio. The study will be conducted in the First Affiliated Hospital of Zhejiang Chinese Medical University (one of the tertiary hospitals in China) from 1 January, 2022, and will end on 31 December 2023. All procedures and time frames are presented in Figure 1 according to the Standard Protocol Items: Recommendations for Interventional Trials (SPIRIT) guidelines.[16]

Recruitment

Eligible patients with UI after RP will be recruited from the inpatient and outpatient departments (mainly the Acupuncture and Moxibustion and Urology departments) of the First Affiliated Hospital of Zhejiang Chinese Medical University according to the inclusion and exclusion criteria. Advertisements will be displayed in health education brochures and posters on the website of the First Affiliated Hospital of Zhejiang Chinese Medical University. Recruitment information will also be released through media, such as websites and mobile phone applications. A written informed consent form will be provided to patients who agree to participate. Once the consent form is

signed, the patient will be included for baseline evaluation and randomization.

Participants

Inclusion criteria

(1) Symptoms of UI after RP with a positive 24-hour pad test (i.e., > 4 g increase in pad weight within 24 h);[17]

(2) Fulfilment of the diagnostic criteria for SUI; i.e., involuntary passing of urine during actions that increase intra-abdominal pressure, such as coughing, laughing, sneezing, and exercising;[18] and

(3) Age between 45 and 80 years.

Exclusion criteria

(1) Urge-predominant mixed UI;

(2) Overflow UI;

(3) UI prior to surgery or UI caused by comorbidities, such as Parkinson's disease, multiple sclerosis, spinal cord injury, Alzheimer's disease, and diabetes mellitus;

(4) Urethral stricture, urinary tract obstruction, refractory urinary tract infection, hydronephrosis, urinary calculi, or tumours;

(5) Use of medications that affect bladder and urinary tract function; or

(6) Severe insufficiency in vital organs, such as the heart, lungs, liver, and kidneys.

Sample size

Referring to a previous study [15] with 96 patients (efficacy rate 68.7%:34.4%), the required sample size was calculated using the Power Analysis and Sample Size 15 software (NCSS Statistical Software, UT, USA). A sample size of 40 patients was determined to have a power (1-beta) of 0.90, an alpha (significance level) of 0.05, and a ratio of 1:1. Taking potential dropouts (10% of the participants) into account, the total sample size was increased to 90 in total (45 in each group).

Randomisation and allocation concealment

The randomisation will be performed by the Clinical Evaluation and Analysis Centre of the First Affiliated Hospital of Zhejiang Chinese Medical University. A random 1:1 allocation sequence will be generated through Statistical Package for the Social Sciences (SPSS) software (v.26.0; Chicago, IL, USA). Professionals who were

involved in the allocation will not be recruited in the study. The random allocation will be strictly kept in an opaque, sequentially numbered envelope that is inaccessible to other research staff. After baseline assessment, the envelope will be opened by an independent staff member in the presence of the participants, who will be assigned into either the treatment or control group. The practitioners will be informed about the participant's allocation at the same time. Randomisation will be requested by the staff member responsible for recruitment and clinical interviewers from the First Affiliated Hospital of Zhejiang Chinese Medical University, who are not allowed to receive information about the group allocation.

Blinding

In this study, participants and practitioners will not be blinded due to the nature of acupuncture. Data analysts will be blinded to the participant's allocation throughout the trial. Telephone interviewers who collect follow-up information will also be blinded. Practitioners will not be permitted to communicate with any data analysts or telephone interviewers. If an unblinding event occurs among data analysts or telephone interviewers, the relevant work will be transferred to other appropriately blinded research staff. The revealing of allocation will only be permitted when it is needed for final comparison between the treatment and control groups.

Intervention

Treatment group

Acupoint selection: We selected 4 specific acupoints in the sacrococcygeal region (that is, the "four sacrococcygeal points"). Upper acupuncture needles will be inserted at points located 1 cm from the sacrococcygeal joint (bilaterally symmetrical), and lower acupuncture needles will be inserted at points located 1 cm from the apex of the coccyx (bilaterally symmetrical) (Figure 2).

Key points of the EPNS process: EPNS will be performed using long acupuncture needles (0.4 mm × 100 mm, Suzhou Shenlong Medical Apparatus Factory, Suzhou, China) on patients lying in the prone position. The upper needles will be inserted vertically to a depth of 75–90 mm for the transmission of needle sensations to the urinary tract or anus, and the lower needles will be inserted diagonally towards the

lateral side (in the direction of the ischiorectal fossa) to a depth of 90–95 mm for the transmission of needle sensations to the perineum (penile root). When the needle sensations have reached the aforementioned body parts, the handles of the needles on each side will be connected to a pair of electrodes on a G6805 electro-acupuncture apparatus ((Shantou Medical Equipment Factory Co. Ltd., Shantou, China) , with the cathode connected to the upper needle and anode connected to the lower needle. Electrical stimulation will be performed using continuous waves at a frequency of 2.5 Hz (150 times/min) and the highest possible intensity (45–55 mA) that the patient can tolerate without experiencing discomfort. Each stimulation session will last for 1 h, and a rhythmic sensation of strong contractions in the upward (cranial) direction centred around the penile root must be maintained in the pelvic floor muscle throughout the electro-acupuncture session. Treatment will be administered once per day from Monday to Friday for eight weeks.

Control group: Patients in the control group will perform PFMT by doing the Kegel exercise.[8] A specialised therapist will provide guidance for training, explain pelvic floor muscle contraction ("stop the flow of urine and shorten the penis while continuing to breathe"), and distribute a written training plan to the patients. During PFMT, patients will be instructed to adopt a standing position, contract the pelvic floor muscles for 10 s, and subsequently relax the muscles for 10 s. The contraction–relaxation cycle is to be repeated ten times to form a set, and the patients will be required to complete three sets per day for eight weeks.

Outcome measures

Baseline assessment

A baseline assessment of the patients will be performed prior to the start of treatment. Basic data will be collected, including age, body mass index, Gleason score for grading prostate cancer, prostate size, surgical method, preservation or non-preservation of neurovascular bundles, and duration of postoperative urinary catheterization. Patients will be asked to record the number of urinary pads required, complete the 24-hour pad test, and assess urinary continence using the International Consultation on Incontinence Questionnaire-Urinary Incontinence Short Form (ICIQ-UI SF).[19] (Supplemental

Table 1)

Primary outcome

Improvement rate has been set as the primary indicator. Scores for the number of urinary pads required, the 24-hour pad test, and responses to the ICIQ-UI SF will be summed to form the total score for each patient, and the improvement rate will be calculated using the following formula:

Improvement rate (%) = [(total score before treatment — total score after treatment) ÷ total score before treatment] × 100

Treatment will be deemed effective when the improvement rate exceeds 25%.

Secondary outcomes

(1) Number of urinary pads used: scores will be awarded based on the number of urinary pads required:[20]

Not required: 0 points;

1–3 pads/week: 1 point;

4–6 pads/week: 2 points;

1–4 pads/day: 3 points;

> 4 pads/day: 4 points.

(2) 24-hour pad test: The weight change of urinary pads after 24 hours will be measured and recorded. Grades of UI severity and scores will be awarded based on the weight of the urinary pad:[17]

< 4 g increase in pad weight within 24 h: negative pad test result, 0 points;

5–20 g increase in pad weight within 24 h: mild incontinence, 2 points;

21–74 g increase in pad weight within 24 h: moderate incontinence, 4 points;

> 75 g increase in pad weight within 24 h: severe incontinence, 6 points.

(3) ICIQ-UI SF score.

Adverse events

An adverse event (AE) of acupuncture will be assessed according to its severity based on local reactions, such as subcutaneous haematoma, subcutaneous bruise, regional muscle spasm, regional pain, regional skin allergy, and infection, or systemic reactions, such as fainting, abdominal distention, vertigo, fatigue, systemic allergy, systemic

infection, and organ injury. Systemic infection and organ injury will be considered severe AEs. The level of severity, time of occurrence, and corresponding management will be recorded on the Case Report Forms (CRFs). All the practitioners and research staff will be trained to deal with AEs, and severe AEs will be reported to the Ethics Committee within 24 h. The Ethics Committee will also decide the necessity for withdrawal of the participant from the trial.

Data management, monitoring, and auditing

The baseline data and assessment information of all participants will be collected by a trained assistant who is blinded to treatment group allocation. The participants will be required to provide the number of pads used for UI, complete the 24-hour pad test, and respond to the ICIQ-UI SF at baseline and after 8 weeks. An independent blinded researcher will conduct telephone interviews of all participants to collect the number of pads they used and the ICIQ-UI SF score at 32 weeks after baseline. All data will be recorded on the CRFs. If a participant discontinues treatment early, their final evaluation data will be collected and used in the analysis.

Upon the completion of the CRFs, including intervention and follow-up, all the participants' data will be entered into an Excel spreadsheet by two independent researchers blinded to the group allocation. An independent supervisor will check the two datasets for accuracy. If inconsistencies are discovered, the supervisor will compare the datasets with the original CRFs and mark the modifications on the CRFs. All the original documents (papers or electronic files) will be accessible only to the principal investigator of the research team. The First Affiliated Hospital of Zhejiang Chinese Medical University will be responsible for the storage and management of all documents.

Members of the Clinical Evaluation and Analysis Centre of the First Affiliated Hospital of Zhejiang Chinese Medical University will organise an independent data monitoring committee who are blinded to the treatment allocations and will meet regularly to monitor the study data. When half of the patients have been randomised and have completed the primary outcome measurement, interim analysis will be performed by the data monitoring committee. The First Affiliated Hospital of Zhejiang Chinese

Medical University will audit this study mainly for participant enrolment, consent, and financial costs.

Statistical analysis

A statistician from the Clinical Evaluation and Analysis Centre of the First Affiliated Hospital of Zhejiang Chinese Medical University will perform all statistical analyses using SPSS Statistics (v.26.0). A normality test will be used to determine whether the data are normally distributed. If there is an imbalance in the baseline characteristics and outcome measures, analysis of covariance will be used. Continuous variables with a normal distribution will be reported as means ± standard deviations, and those with a non-normal distribution or ordinal variables will be expressed as medians (with lower and upper quartiles). Counts and proportions will be expressed for categorical variables. The last observation carried forward method will be used to process the missing data.

For the primary outcome measures, Student's t-tests will be used to analyse normally distributed data. A paired t-test will be used to compare pre-treatment and post-treatment improvement rates. An independent sample t-test will be used to compare improvement rates between the two groups. For non-normally distributed data, a Mann–Whitney U test will be used for between-group comparison, and a Wilcoxon signed rank test will be used to compare pre-treatment and post-treatment improvement rates. Differences between the two groups will be compared by the inter-group rank sum test.

The secondary outcome measures—including scores for the number of pads used, the 24-hour pad test, and responses to the ICIQ-UI SF—will be analysed following the same methods as those used to analyse the primary outcome measures. All reported P-values will be two-tailed, and confidence intervals will be at the 95% level. A P-value of < 0.05 will be considered statistically significant.

Patient and public involvement

The patients and general public are not directly involved in the design, recruitment, or conduct of this pilot study. The design of the study is based on existing knowledge from our previous studies on female SUI as well as communications with colleagues from the Urology department. At the end of this trial, the results of this study will be

disseminated in peer-reviewed journals and at academic conferences. A brief plain language summary of the results will be displayed for the patients on a website (https://sandychenshan.haodf.com/) and on BiliBili (a video sharing mobile phone application).

ETHICS AND DISSEMINATION

The Ethics Committee of the First Affiliated Hospital of Zhejiang Chinese Medical University has reviewed and approved this protocol (approval no. 2021-KL-040-02). This study will adhere to the principles of the Declaration of Helsinki. The study will be conducted at the First Affiliated Hospital of Zhejiang Chinese Medical University.

Each participant will voluntarily sign a written informed consent form. Each study participant will be assigned an identification number throughout the trial to assure confidentiality. The results of this study will be published in open-access and peer-reviewed journals and presented at relevant conferences.

DISCUSSION

In men, urinary control is mainly realised through support from the urethral sphincter complex (including the internal and external urethral sphincters) and surrounding pelvic floor muscles (including the levator ani muscle).[21]The internal urethral sphincter consists of smooth muscles and is innervated by the sympathetic nervous system; the external urethral sphincter consists of striated muscles and, like the levator ani muscle, is mainly innervated by the pudendal nerve.[22] RP inevitably requires the resection of sphincter muscle tissue fibres surrounding the prostate, leading to damage to the function of the internal urethral sphincter. Therefore, following RP, urinary control depends primarily on the support of the external urethral sphincter and pelvic floor muscles. [23]

The 2019 guidelines on incontinence after prostate cancer treatment published by the American Urological Association (AUA) state that PFMT is beneficial for the postoperative recovery of urinary control. However, surgical methods are recommended for patients with severe UI or UI that persists at 1 year postoperatively[24]. In our clinical work, we have found that in patients with UI lasting

for > 1 year, the severity of UI can decrease from severe to mild after EPNS treatment, which considerably enhances the quality of life of these patients. We have also received feedback from patients about their inability to perform PFMT correctly and the difficulties they face in persevering with PFMT in the long term (due to the long treatment duration). With EPNS treatment, patients were able to sense strong contractions in their pelvic floor muscles during the treatment process, and some patients observed a reduction in the amount of urine leaked within 1 to 2 weeks. These observations and the findings of our previous studies jointly indicate that EPNS is indeed capable of stimulating the pudendal nerve, which triggers rhythmic contractions of the pelvic floor muscles and enables the simulation of PFMT. Therefore, the proposed trial aims to compare the clinical efficacies of EPNS and PFMT in treating PPUI.

We selected points on the body surface located 1 cm from the sacrococcygeal joint (bilaterally symmetrical) for the vertical insertion of upper acupuncture needles because the main trunk of the pudendal nerve passes through this region.[25] During the needle insertion process, needle sensations can be transmitted to the urinary tract or anus because the pudendal nerve contains sensory fibres innervating the external genitalia and anus.[22] In the ischiorectal fossa, the pudendal nerve divides into the perineal nerve (innervating the external urethral sphincter, levator ani muscle, superficial perineal muscles, and scrotal skin) and the dorsal nerve of the penis/clitoris (innervating the skin of the penis/clitoris).[27] Therefore, we selected points on the body surface located 1 cm from the apex of the coccyx (bilaterally symmetrical) for the diagonal insertion of lower acupuncture needles in the direction of the ischiorectal fossa. When the needle tips reach the perineal nerve, needle sensations are solely transmitted to the urinary tract (Figures 3-4). As a result, electrical stimulation using these needles produces rhythmic, strong contractions of the pelvic floor muscles centred around the penile root in the upward direction.

This study has the following strengths. (1) This protocol is the first to compare the clinical efficacies of EPNS and PFMT in the treatment of PPUI. (2) Based on our previous work, we have optimised the outcome assessment and included the 24-hour

pad test, which provides a good indication of actual urine leakage in patients. [17] Although the number of pads used may change significantly in patients with severe UI, this is not the case in patients with moderate or mild UI, as they generally use 1–2 pads per day. This makes it difficult to observe changes in the amount of urine leakage, and our protocol ensures that these data will be recorded accurately. (3) All patients will be followed up at 6 months after the completion of treatment for the observation of the long-term efficacy of EPNS.

The limitations of this trial are as follows. (1) Owing to the nature of acupuncture, acupuncturists and participants will not be blinded. (2) Although PFMT will be adopted as a treatment for the control group, the inability of patients to persevere with PFMT has been encountered in clinical practice and reported in the literature,[27] which may potentially affect the treatment efficacy in the control group. To address this issue, we will create an instructional video and engage a specialized therapist to help patients master the correct techniques of PFMT. We will also employ dedicated personnel who will supervise patients, help them complete the training through WeChat or phone calls (three times a week), and perform detailed recording of the patients' training status.

Author Contributions

SC conceived the study and developed the protocol; SYW and YQG contributed to the study design; SL contributed to the sample size calculation and planned the statistical analysis; and LHX and SHW prepared the flowchart, figures, and tables. All authors have read and approved the final manuscript.

Funding Statement

This work was supported by Zhejiang Provincial Administration of Traditional Chinese Medicine (grant number 2021ZA056).

Competing Interests Statement

None.

Ethics approval

This protocol was approved by the Ethics Committee of the First Affiliated Hospital of Zhejiang Chinese Medical University.

Provenance and peer review

Not commissioned; externally peer reviewed.

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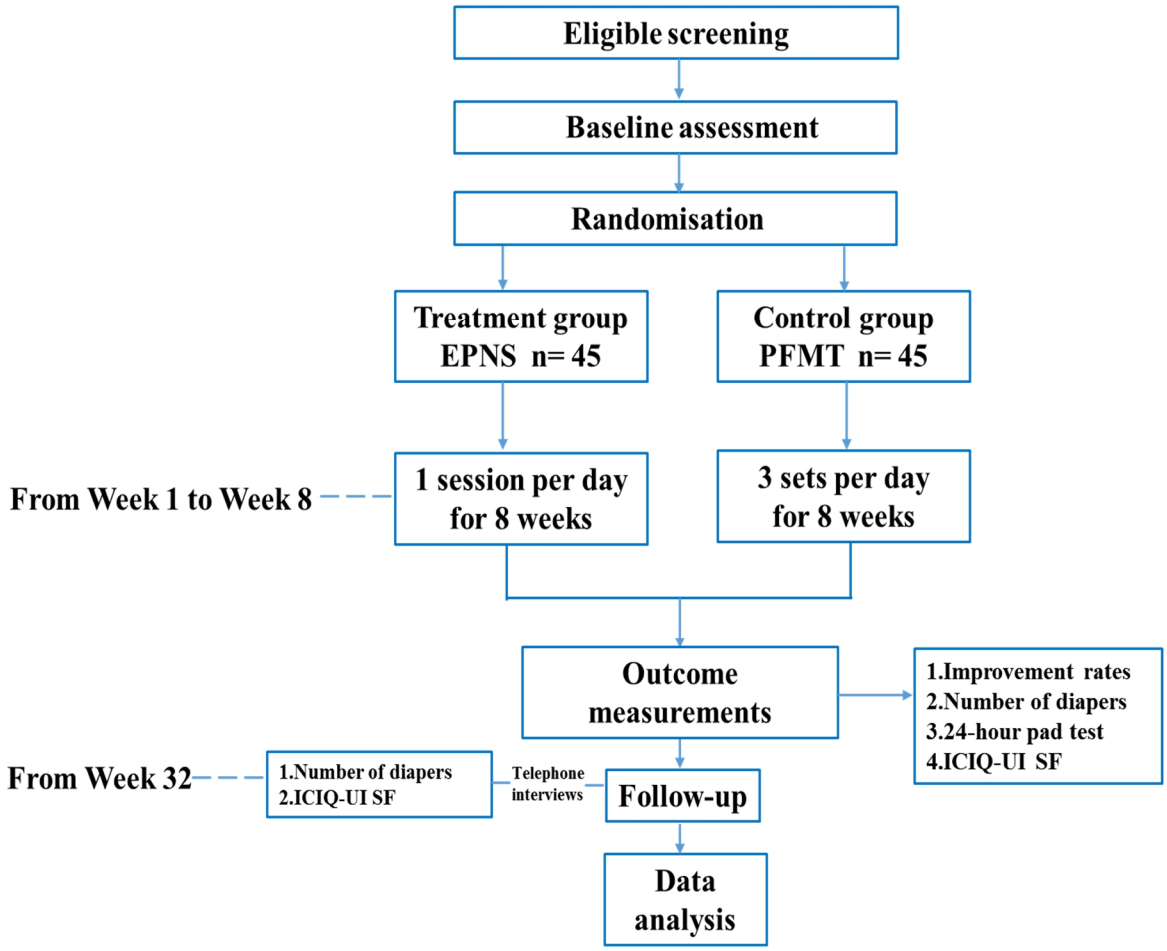
Figure legends:

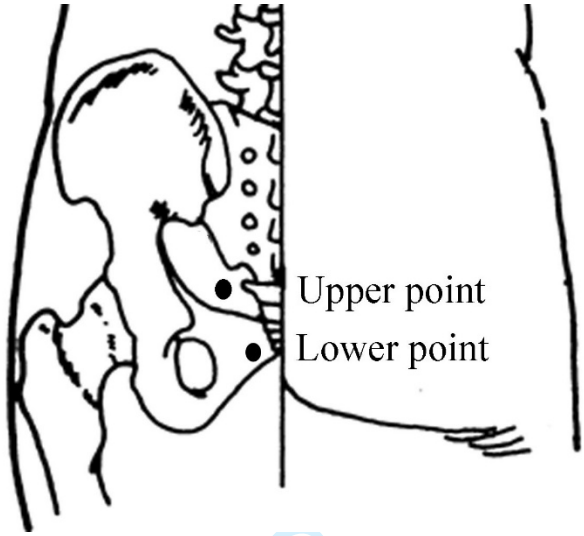
Figure 1. Flow diagram detailing the study procedure

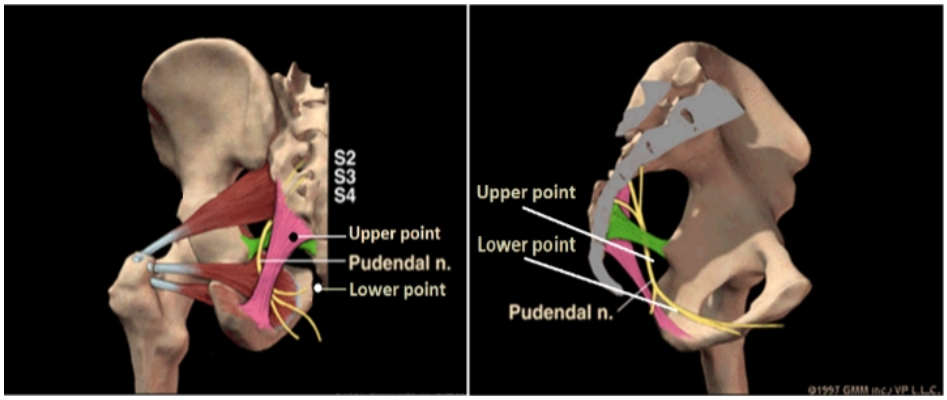
Figure 2. Location of the ‘four sacrococcygeal points’ for electrical pudendal nerve stimulation

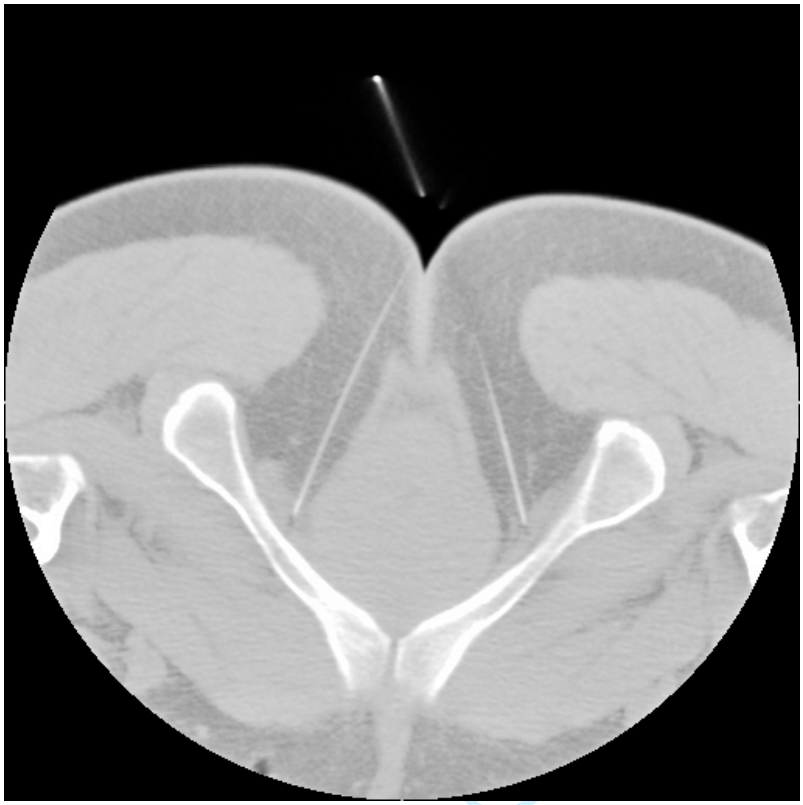
Figure 3. Anatomical positions of the ‘four sacrococcygeal points’ for electrical pudendal nerve stimulation

Figure 4. Transverse computed tomography image of the coccygeal apex.
The tip of the needle inserted at the lower sacral point is visible
in the ischiorectal fossa (adjacent to the pudendal nerve in
the Alcock’s canal).









Supplemental Table 1. International Consultation on Incontinence Questionnaire - Urinary Incontinence Short Form (ICIQ-UI SF)

1. Please write your date of birth:	□□ □□ □□ Date Month Year	
2. To which gender identity do you most identify?	Female □ Male □	
3. How often do you leak urine? (Tick one box)		
	Never	□ 0
	About once a week or less often	□ 1
	Two or three times a week	□ 2
	About once a day	□ 3
	Several times a day	□ 4
	All the time	□ 5
4. We would like to know how much urine you think leaks. How much urine do you usually leak (whether you wear protection or not)? (Tick one box)		
	None	□ 0
	A small amount	□ 2
	A moderate amount	□ 4
	A large amount	□ 6
5. Overall, how much does leaking urine interfere with your everyday life?		

Please circle a number between 0 (not at all) and 10 (a great deal)

0 1 2 3 4 5 6 7 8 9 10

Not at all A great deal

ICIQ score: sum scores 3+4+5 □□

6. When does urine leak? (Please tick all that apply to you)

Never – urine does not leak □

Before you can get to the toilet □

When you cough or sneeze □

When you are asleep □

When you have finished urinating and are dressed □

For no obvious reason □

All the time □

BMJ Open

Efficacy of electrical pudendal nerve stimulation versus pelvic floor muscle training in treating post-radical prostatectomy urinary incontinence: study protocol for a randomised controlled trial

Journal:	*BMJ Open*
Manuscript ID	bmjopen-2022-062323.R1
Article Type:	Protocol
Date Submitted by the Author:	21-Sep-2022
Complete List of Authors:	Chen, Shan; Zhejiang University of Traditional Chinese Medicine First Affiliated Hospital, Department of Acupuncture and Moxibustion Wang, Siyou; Shanghai Yueyang Hospital, Clinical Research Section, Shanghai Research Institute of Acupuncture and Meridian Liu, Shan; Zhejiang University of Traditional Chinese Medicine First Affiliated Hospital, Clinical Evaluation and Analysis Center Wang, Shenhong; Zhejiang University of Traditional Chinese Medicine First Affiliated Hospital, Department of Urology Xuan, Lihua; Zhejiang University of Traditional Chinese Medicine First Affiliated Hospital, Department of Acupuncture and Moxibustion Gao, Yunqiu; Zhejiang University of Traditional Chinese Medicine First Affiliated Hospital, Department of Urology
Primary Subject Heading:	Rehabilitation medicine
Secondary Subject Heading:	Urology
Keywords:	Urinary incontinences < UROLOGY, Prostate disease < UROLOGY, UROLOGY

Efficacy of electrical pudendal nerve stimulation versus pelvic floor muscle training in treating post-radical prostatectomy urinary incontinence: study protocol for a randomised controlled trial

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Word count: 4600

ABSTRACT

Introduction: Urinary incontinence (UI) is one of the main complications of radical prostatectomy. Electrical pudendal nerve stimulation (EPNS) has been used to treat stress UI based on its mechanism of passive pelvic floor muscle contraction reported in previous research. However, there are no studies comparing the effects of EPNS and active pelvic floor muscle training (PFMT) in the treatment of post-radical prostatectomy UI (PPUI). Here, we describe the protocol for a randomised controlled trial to evaluate the efficacy of EPNS in treating PPUI compared with PFMT.

Methods and analysis: This study is designed as an open-label randomised controlled trial with blinded assessment and analysis. A total of 90 eligible men will be randomly allocated to two groups. The treatment group (n = 45) will receive EPNS while the control group will perform PFMT by doing the Kegel exercise. Forty EPNS treatment sessions will occur over a period of 8 weeks. The primary outcome measure will be improvement rate, and the secondary outcome measures, the number of pads used, 24-hour pad test, and International Consultation on Incontinence Questionnaire-Urinary Incontinence Short Form (ICIQ-UI SF) will be compared between baseline and the study endpoint. The International Consultation on Incontinence Questionnaire-Lower Urinary Tract Symptoms Quality of Life (ICIQ-LUTS-QOL) and care compared as the quality of life and satisfaction outcomes between groups.

Ethics and dissemination: This protocol has been approved by the Ethics Committee of the First Affiliated Hospital of Zhejiang Chinese Medical University (approval no. 2021-KL-040-02). Written informed consent will be obtained from each participant. The results of the study will be published in peer-reviewed journals.

Trial registration number: ChiCTR2200055461

Strengths and limitations of this study

- The design of this trial compares the clinical efficacies of EPNS and PFMT in the treatment of PPUI.
- The severity of urine leakage after PPUI is assessed by a 24-h pad test scoring

system in our protocol.

- A supervised PFMT is performed by a physiotherapist through a mobile app, WeChat, to improve the participants' adherence to PFMT.
- Owing to the nature of acupuncture, acupuncturists and participants are not blinded.
- The objective workup, such as urodynamic study and cystoscopy to segregate SUI patients from those with predominant urgency incontinence and overflow urinary incontinence, is lacking.

INTRODUCTION

Urinary incontinence (UI) is one of the main complications of radical prostatectomy (RP).The incidence of post-radical prostatectomy UI (PPUI) ranges from 5% to 70% [1],with the incidence of UI at 12 months postoperatively exceeding 20% [2,3]. Besides posing a heavy economic burden, UI also has a considerable negative impact on the social life and interpersonal relationships of patients[3,4]. Stress urinary incontinence (SUI) is the main type of PPUI [5]; however, there are currently no recommended pharmacological agents for the non-surgical treatment of PPUI [6]. At present, pelvic floor muscle training (PFMT) is the most widely used approach for treating PPUI [6,7]. Although PFMT enables the strengthening of pelvic floor muscles [8], many patients find it difficult to perform the training correctly. In addition, the relatively long treatment duration makes it difficult for patients to persist with PFMT in the long term, ultimately resulting in poor treatment adherence [9]. Transanal electrical stimulation is a non-invasive, passive method of pelvic floor muscle training that enhances patient adherence [10]. However, its effects are indirect in nature owing to the use of surface electrodes. A study comparing the effects of PFMT alone and in combination with transanal electrical stimulation for the treatment of PPUI reported that although both regimens improved UI, the difference in their effects was not statistically significant [10,11].

Electrical pudendal nerve stimulation (EPNS) is a novel technique for the treatment of SUI. In previous studies, we used computed tomography in the transverse plane with simultaneous pelvic floor measurements to demonstrate that EPNS enabled pelvic floor muscle contraction and was effective in treating female SUI and urge incontinence [12-14]. In a recent study, we used simultaneous measurements of movement and surface electromyography of the pelvic floor muscles in male subjects to show that EPNS promoted the contraction and strengthening of pelvic floor muscles and the simulation of PFMT, thus leading to the effective treatment of PPUI [15]. Compared with active PFMT, EPNS can provide highly effective passive training for the pelvic floor muscles. This can help address the difficulties faced by patients in correctly locating the pelvic

floor muscles and persisting with PFMT, thus improving overall patient adherence. However, across studies, there are significant differences in the indicators and assessment techniques for determining the degree of UI, and the long-term efficacy of EPNS for treating PPUI has not been reported. In addition, although it is known that EPNS can simulate PFMT, there are no studies comparing the effects of EPNS and PFMT in the treatment of PPUI.

Objective

This trial aims to evaluate the long-term efficacy of EPNS in treating PPUI through the establishment of a PFMT control group and adoption of comprehensive assessment criteria and indicators.

METHODS AND ANALYSIS

Study design

This trial will compare the efficacy of EPNS with that of PFMT for the treatment of PPUI. It will be designed as a blind randomised study, and data will be analysed for two parallel groups over an 8-week treatment period. Ninety participants with PPUI will be randomly assigned to the treatment and control groups at a 1:1 ratio. The study will be conducted in the First Affiliated Hospital of Zhejiang Chinese Medical University (one of the tertiary hospitals in China) from 1 January, 2022, and will end on 31 December 2023. All procedures and time frames are presented in Figure 1 according to the Standard Protocol Items: Recommendations for Interventional Trials (SPIRIT) guidelines [16].

Recruitment

Eligible patients with UI after RP will be recruited from the inpatient and outpatient departments (mainly the Acupuncture and Moxibustion and Urology departments) of the First Affiliated Hospital of Zhejiang Chinese Medical University according to the inclusion and exclusion criteria. Advertisements will be displayed in health education brochures and posters on the website of the First Affiliated Hospital of Zhejiang Chinese Medical University. At the beginning of recruitment, detailed information

about the study, including the research objective, study procedure, and potential benefits and risks, are provided to all eligible patients. Recruitment information will also be released through media, such as websites and mobile phone applications. A written informed consent form (Supplementary file 1) will be given to patients who agree to participate. Once the consent form is signed, the patient will be included for baseline evaluation and randomisation.

Participants

Inclusion criteria

(1) Incontinence at 1 month or more after RP;

(2) Symptoms of UI after RP with a positive 24-hour pad test (i.e., >4 g increase in pad weight within 24 h) [17];

(3) Fulfilment of the diagnostic criteria for SUI or stress-predominant mixed urinary incontinence (MUI) [18]; with the additional use of a scored urinary incontinence questionnaire comprising 15 questions (Supplemental Table1) [19-20] (Figure 2).

(4) No residual cancer after RP on pathological examination and

(5) Age between 45 and 80 years.

Exclusion criteria

(1) Urge-predominant MUI;

(2) Overflow UI;

(3) UI prior to surgery or UI caused by comorbidities, such as Parkinson's disease, multiple sclerosis, spinal cord injury, Alzheimer's disease, and diabetes mellitus;

(4) Undergoing or had prior radiation therapies;

(5) Difficulty in voiding

(6) Urethral stricture, urinary tract obstruction, bladder neck obstruction, refractory urinary tract infection, hydronephrosis, urinary calculi, or tumours;

(7)Use of medications that affect bladder function (e.g., antimuscarinics or beta-3 agonists); or

(8)Severe insufficiency in vital organs, such as the heart, lungs, liver, and kidneys.

Participants with PPUI excluded from our study will be referred to a specialist to address their primary lesions first and will have a choice to receive EPNS or PFMT decided without taking part in our trial analysis.

Sample size

Referring to a previous study [15] with 96 patients (efficacy rate 68.7%:34.4%), the required sample size was calculated using the Power Analysis and Sample Size 15 software (NCSS Statistical Software, UT, USA). A sample size of 40 patients was determined to have a power (1-beta) of 0.90, an alpha (significance level) of 0.05, and a ratio of 1:1. Taking potential dropouts (10% of the participants) into account, the total sample size was increased to 90 in total (45 in each group).

Randomisation and allocation concealment

The randomisation will be performed by the Clinical Evaluation and Analysis Centre of the First Affiliated Hospital of Zhejiang Chinese Medical University. A random 1:1 allocation sequence will be generated through Statistical Package for the Social Sciences (SPSS) software (v.26.0; Chicago, IL, USA). Professionals involved in the allocation will not be recruited in the study. The random allocation will be strictly kept in an opaque, sequentially numbered envelope that is inaccessible to other research staff. After baseline assessment, the envelope will be opened by an independent staff member in the presence of the participants, who will be assigned into either the treatment or control group. The acupuncturists will be informed about the participant's allocation at the same time. Randomisation will be requested by the staff member responsible for recruitment and clinical interviewers from the First Affiliated Hospital of Zhejiang Chinese Medical University, who are not allowed to receive information about the group allocation.

Blinding

In this study, participants and acupuncturists will not be blinded due to the nature of acupuncture. Data analysts will be blinded to the participant's allocation throughout the trial. Telephone interviewers who collect follow-up information will also be blinded. Acupuncturists will not be permitted to communicate with any data analysts or telephone interviewers. If an unblinding event occurs among data analystsor telephone interviewers, the relevant work will be transferred to other appropriately blinded research staff. The revealing of allocation will only be permitted when it is needed for

final comparison between the treatment and control groups.

Intervention

Treatment group

Acupoint selection: We select 4 specific acupoints in the sacrococcygeal region (that is, the "four sacrococcygeal points"). Upper acupuncture needles will be inserted at points located 1 cm from the sacrococcygeal joint (bilaterally symmetrical), and lower acupuncture needles will be inserted at points located 1 cm from the apex of the coccyx (bilaterally symmetrical) (Figure 3).

Key points of the EPNS process: EPNS will be performed using long acupuncture needles (0.4 mm × 100 mm, Suzhou Shenlong Medical Apparatus Factory, Suzhou, China) on patients lying in the prone position. The upper needles will be inserted vertically to a depth of 75–90 mm for the transmission of needle sensations to the urinary tract or anus, and the lower needles will be inserted diagonally towards the lateral side (in the direction of the ischiorectal fossa) to a depth of 90–95mm for the transmission of needle sensations to the perineum (penile root).When the needle sensations have reached the aforementioned body parts, the handles of the needles on each side will be connected to a pair of electrodes on a G6805 electro-acupuncture apparatus ((Shantou Medical Equipment Factory Co. Ltd., Shantou, China), with the cathode connected to the upper needle and anode connected to the lower needle. Electrical stimulation will be performed using continuous waves at a frequency of 2.5 Hz (150 times/min) and the highest possible intensity (45–55 mA) that the patient can tolerate without experiencing discomfort. Each stimulation session will last for 1 h, and a rhythmic sensation of strong contractions in the upward (cranial) direction centred around the penile root must be maintained in the pelvic floor muscle throughout the electro-acupuncture session. Treatment will be administered once per day from Monday to Friday for eight weeks.

Control group: Patients in the control group will perform PFMT by doing the Kegel exercise.[8,10]A physiotherapist will provide guidance for training, explain pelvic floor muscle contraction, and give the instructions like "stop the flow of urine and shorten

the penis while continuing to breathe" [21]. A digital anal examination using the Oxford score (graded 0–5) will be applied by the therapist when giving instructions and will be communicated with the patients by verbal feedback [22]. Once the patients' abilities are known, they will be required to contract the pelvic floor muscles as much as possible for 3–10 s, depending on their ability and subsequently relax the muscles for an equal period of time. The contraction–relaxation cycle is to be repeated 15 times to form a set, and patients will be required to complete three sets daily in three positions after RP at home. In addition, a written training diary (Table 1) will be given to the patients for ongoing training for 8 weeks.

Table 1 PFMT diary

PFMT therapy							
Name Date of first visit							
Everyday exercises at home: Three sets of exercises with 15 repetitions of a 3- to 10-s contraction followed by an equal period of relaxation							
In supine	15 repetitions			squeeze for 3-10 s		relax for equal time	
Sitting	15 repetitions			squeeze for 3-10s		relax for equal time	
Standing	15 repetitions			squeeze for 3-10 s		relax for equal time	
when you finish the day's home exercises, please write down the date at the following squares numbered from week 1 to 8							
Week Date	eg:2022/9/3						
1							
2							
3							
4							
5							
6							
7							
8							

Tips: If you have any questions, please do not hesitate to call us:

Office Tel: 0571-86919352 (08:00-17:00),

or you can scan our WeChat (a social media mobile app) QR-code for detailed information.

WeChat Official Acount Department of Acupuncture and Moxibustion, the First Affiliated Hospital of Zhejiang Chinese Medical University

The physiotherapist will pay a one-time office visit when the participants are recruited at baseline assessment interview on the PFMT technique and will continue with 24 times of online visits through WeChat (a social media mobile app) or phone calls (a few older people do not know how to use smartphones) three times a week for better execution of PFMT at home.

Fluid intake of patients in both groups will also be advised by clinicians during the 8-week trial time, recommending six glasses (approximately 1,200–1,500 mL) of fluid to take during the day and informing them to avoid having coffee, tea, or alcohol, which may induce an increased risk of leakage.

Dropout criteria

(1) Poor participant compliance (lack of adherence to treatment for personal reasons).

(2) Serious adverse events, complications, or special physiological changes necessitating discontinuation of the intervention.

(3) Voluntary dropout.

Outcome measures

Baseline assessment

A baseline assessment of the patients will be performed prior to the start of treatment. Basic data will be collected, including age, body mass index, Gleason score for grading prostate cancer, prostate size, surgical method preservation or non-preservation of neurovascular bundles, and duration of postoperative urinary catheterisation, as well as a B ultrasound of urinary system, including residual urine. Patients will be asked to record the number of urinary pads required, complete the 24-hour pad test, and assess urinary continence using the International Consultation on Incontinence Questionnaire-Urinary Incontinence Short Form (ICIQ-UI SF) [23](Supplemental Table 2) and The International Consultation on Incontinence Questionnaire-Lower Urinary Tract Symptoms Quality of Life (ICIQ-LUTS-QOL) [24] (Supplemental Table 3). The pad test procedure is provided in Supplemental Table 4 [25].

Primary outcome

Improvement rate has been set as the primary indicator. Scores for the number of urinary pads required, the 24-hour pad test, and responses to the ICIQ-UI SF will be summed to form the total score for each patient, and the improvement rate will be calculated using the following formula:

Improvement rate (%)=[(total score before treatment— total score after treatment)÷total score before treatment]×100

Treatment will be deemed effective when the improvement rate exceeds 25%.

Secondary outcomes

(1) Number of urinary pads used: scores will be awarded based on the number of urinary pads required: [26]

Not required: 0 points;

1–3 pads/week: 1point;

4–6pads/week: 2points;

1–4pads/day: 3points;

>4 pads/day: 4points.

(2)24-hour pad test: The weight change of urinary pads after 24 hours will be measured by a digital scale and recorded. Grades of UI severity and scores will be awarded based on the weight of the urinary pad: [17,27]

< 4 gincrease in pad weight within 24 h: negative pad test result, 0 points;

5–20 g increase in pad weight within 24 h: mild incontinence, 2 points;

21–74 g increase in pad weight within 24 h: moderate incontinence, 4 points;

> 75 g increase in pad weight within 24 h: severe incontinence, 6 points.

(3)ICIQ-UI SF score.

Quality of life and satisfaction outcomes

(1) ICIQ-LUTS-QOL score.

(2) Patient Global Impression of Improvement (PGI-I) score. The PGI-I is given a numerical score from 1 (very much better) to 7 (very much worse). [28](Supplemental Table 5)

Adverse events

An adverse event (AE) of acupuncture will be assessed according to its severity based on local reactions, such as subcutaneous haematoma, subcutaneous bruise, regional muscle spasm, regional pain, regional skin allergy, and infection, or systemic reactions, such as fainting, abdominal distention, vertigo, fatigue, systemic allergy, systemic infection, and organ injury. Systemic infection and organ injury will be considered severe AEs. The level of severity, time of occurrence, and corresponding management will be recorded on the Case Report Forms (CRFs). All the acupuncturists and research staff will be trained to deal with AEs, and severe AEs will be reported to the Ethics Committee within 24 h. The Ethics Committee will also decide the necessity for withdrawal of the participant from the trial.

Patients having local adverse reactions will be given medical care to ease the bleeding, irritation, and bruising. Those having severe reactions leading to organ injury, systematic infection, and systematic allergy will be given compensation by our research team to cover their medical costs.

Data management, monitoring, and auditing

The baseline data and assessment information of all participants will be collected by a trained assistant who is blinded to treatment group allocation. The participants will be required to provide the number of pads used for UI, complete the 24-hour pad test, and respond to the ICIQ-UI SF and ICIQ-LUTS-QOL at baseline and after 8 weeks. PGI-I will be provided after 8-week intervention. An independent blinded researcher will conduct telephone interviews of all participants to collect the number of pads they used and, ICIQ-UI SF score, ICIQ-LUTS-QOL score, and PGI-I at 32 weeks after baseline. All data will be recorded on the CRFs. If a participant discontinues treatment early, their final evaluation data will be collected and used in the analysis.

Upon the completion of the CRFs, including intervention and follow-up, all the participants' data will be entered into an Excel spreadsheet by two independent researchers blinded to the group allocation. An independent supervisor will check the two datasets for accuracy. If inconsistencies are discovered, the supervisor will compare the datasets with the original CRFs and mark the modifications on the CRFs. All the

original documents (papers or electronic files) will be accessible only to the principal investigator of the research team. The First Affiliated Hospital of Zhejiang Chinese Medical University will be responsible for the storage and management of all documents.

Members of the Clinical Evaluation and Analysis Centre of the First Affiliated Hospital of Zhejiang Chinese Medical University will organise an independent data monitoring committee who are blinded to the treatment allocations and will meet regularly to monitor the study data. When half of the patients have been randomised and have completed the primary outcome measurement, interim analysis will be performed by the data monitoring committee. The First Affiliated Hospital of Zhejiang Chinese Medical University will audit this study mainly for participant enrolment, consent, and financial costs.

Statistical analysis

A statistician from the Clinical Evaluation and Analysis Centre of the First Affiliated Hospital of Zhejiang Chinese Medical University will perform all statistical analyses using SPSS Statistics (v.26.0). A normality test will be used to determine whether the data are normally distributed. If there is an imbalance in the baseline characteristics and outcome measures, analysis of covariance will be used. Continuous variables with a normal distribution will be reported as means ± standard deviations, and those with a non-normal distribution or ordinal variables will be expressed as medians (with lower and upper quartiles). Counts and proportions will be expressed for categorical variables. The last observation carried forward method will be used to process the missing data.

For the primary outcome measures, Student's t-tests will be used to analyse normally distributed data. A paired t-test will be used to compare pre-treatment and post-treatment improvement rates. An independent sample t-test will be used to compare improvement rates between the two groups. For non-normally distributed data, a Mann–Whitney U test will be used for between-group comparison, and a Wilcoxon signed rank test will be used to compare pre-treatment and post-treatment improvement rates. Differences between the two groups will be compared by the inter-group rank

sum test.

The secondary outcome measures—including scores for the number of pads used, the 24-hour pad test, and responses to the ICIQ-UI SF—will be analysed following the same methods as those used to analyse the primary outcome measures. All reported P-values will be two-tailed, and confidence intervals will be at the 95% level. A P-value of <0.05 will be considered statistically significant.

The quality of life and satisfaction outcomes, ICIQ-LUTS-QOL score and PGI-I score will be analysed following the same methods.

Patient and public involvement

The patients and general public are not directly involved in the design, recruitment, or conduct of this pilot study. The design of the study is based on existing knowledge from our previous studies on female SUI as well as communications with colleagues from the Urology department. At the end of this trial, the results of this study will be disseminated in peer-reviewed journals and at academic conferences. A brief plain language summary of the results will be displayed for the patients on a website (https://sandychenshan.haodf.com/) and on BiliBili (a video sharing mobile phone application).

ETHICS AND DISSEMINATION

The Ethics Committee of the First Affiliated Hospital of Zhejiang Chinese Medical University has reviewed and approved this protocol (approval no. 2021-KL-040-02). This study will adhere to the principles of the Declaration of Helsinki. The study will be conducted at the First Affiliated Hospital of Zhejiang Chinese Medical University.

Each participant will voluntarily sign a written informed consent form. Each study participant will be assigned an identification number throughout the trial to assure confidentiality. The results of this study will be published in open-access and peer-reviewed journals and presented at relevant conferences.

DISCUSSION

In men, urinary control is mainly realised through support from the urethral sphincter

complex (including the internal and external urethral sphincters) and surrounding pelvic floor muscles (including the levator ani muscle) [29]. The internal urethral sphincter consists of smooth muscles and is innervated by the sympathetic nervous system; the external urethral sphincter consists of striated muscles and, like the levator ani muscle, is mainly innervated by the pudendal nerve [30]. RP inevitably requires the resection of sphincter muscle tissue fibres surrounding the prostate, leading to damage to the function of the internal urethral sphincter. Therefore, following RP, urinary control depends primarily on the support of the external urethral sphincter and pelvic floor muscles [31].

The 2019 guidelines on incontinence after prostate cancer treatment published by the American Urological Association (AUA) state that PFMT is beneficial for the postoperative recovery of urinary control. However, surgical methods are recommended for patients with severe UI or UI that persists at 1 year postoperatively [32]. In our clinical work, we have found that in patients with UI lasting for > 1 year, the severity of UI can decrease from severe to mild after EPNS treatment, which considerably enhances the quality of life of these patients. We have also received feedback from patients about their inability to perform PFMT correctly and the difficulties they face in persevering with PFMT in the long term (due to the long treatment duration).With EPNS treatment, patients were able to sense strong contractions in their pelvic floor muscles during the treatment process, and some patients observed a reduction in the amount of urine leaked within 1 to 2 weeks. These observations and the findings of our previous studies jointly indicate that EPNS is indeed capable of stimulating the pudendal nerve, which triggers rhythmic contractions of the pelvic floor muscles and enables the simulation of PFMT. Therefore, the proposed trial aims to compare the clinical efficacies of EPNS and PFMT in treating PPUI.

We selected points on the body surface located 1 cm from the sacrococcygeal joint (bilaterally symmetrical) for the vertical insertion of upper acupuncture needles because the main trunk of the pudendal nerve passes through this region [33]. During the needle

insertion process, needle sensations can be transmitted to the urinary tract or anus because the pudendal nerve contains sensory fibres innervating the external genitalia and anus [30] In the ischiorectal fossa, the pudendal nerve divides into the perineal nerve(innervating the external urethral sphincter, levator ani muscle, superficial perineal muscles, and scrotal skin) and the dorsal nerve of the penis/clitoris (innervating the skin of the penis/clitoris) [34] Therefore, we selected points on the body surface located 1 cm from the apex of the coccyx (bilaterally symmetrical) for the diagonal insertion of lower acupuncture needles in the direction of the ischiorectal fossa. When the needle tips reach the perineal nerve, needle sensations are solely transmitted to the urinary tract (Figures 4-5). As a result, electrical stimulation using these needles produces rhythmic, strong contractions of the pelvic floor muscles centred around the penile root in the upward direction.

PFMT will be adopted as a treatment for the control group, yet the inability of patients to persevere with PFMT has been encountered in clinical practice and reported in the literature [35], which may potentially affect the treatment efficacy in the control group. Mobile apps have been increasingly used to address this issue and facilitate patients' compliance with PFMT [36-37]. In our study, we adopted WeChat, a social media mobile app, to provide a supervised PFMT through dedicated physiotherapy in our clinical trial.

This study has the following strengths. (1) This protocol is the first to compare the clinical efficacies of EPNS and PFMT in the treatment of PPUI. (2) Based on our previous work, we have optimised the outcome assessment and included the 24-hour pad test, which provides a good indication of actual urine leakage in patients [17]. Although the number of pads used may change significantly in patients with severe UI, this is not the case in patients with moderate or mild UI, as they generally use 1–2 pads per day. This makes it difficult to observe changes in the amount of urine leakage, and our protocol ensures that these data will be recorded accurately. (3)All patients will be followed up at 6 months after the completion of treatment for the observation of the long-term efficacy of EPNS.

The limitations of this trial are as follows. (1) Owing to the nature of acupuncture, acupuncturists and participants will not be blinded. (2) The objective workup, such as urodynamic study and cystoscopy to specifically segregate SUI patients from those with predominant urgency incontinence and overflow urinary incontinence, is lacking. (3) Although it has been designed that both short- and long-term effects will be followed, the overall study duration is relatively short for PPUI, some of which could last for years.

Author contributions

SC conceived the study and developed the protocol; SYW and YQG contributed to the study design; SL contributed to the sample size calculation and planned the statistical analysis; and LHX and SHW prepared the flowchart, figures, and tables. All authors have read and approved the final manuscript.

Funding statement

This work was supported by Zhejiang Provincial Administration of Traditional Chinese Medicine (grant number 2021ZA056).

Competing interests statement

None.

Ethics approval

This protocol was approved by the Ethics Committee of the First Affiliated Hospital of Zhejiang Chinese Medical University.

Provenance and peer review

Not commissioned; externally peer reviewed.

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Figure legends:

Figure 1. Flow diagram detailing the study procedure

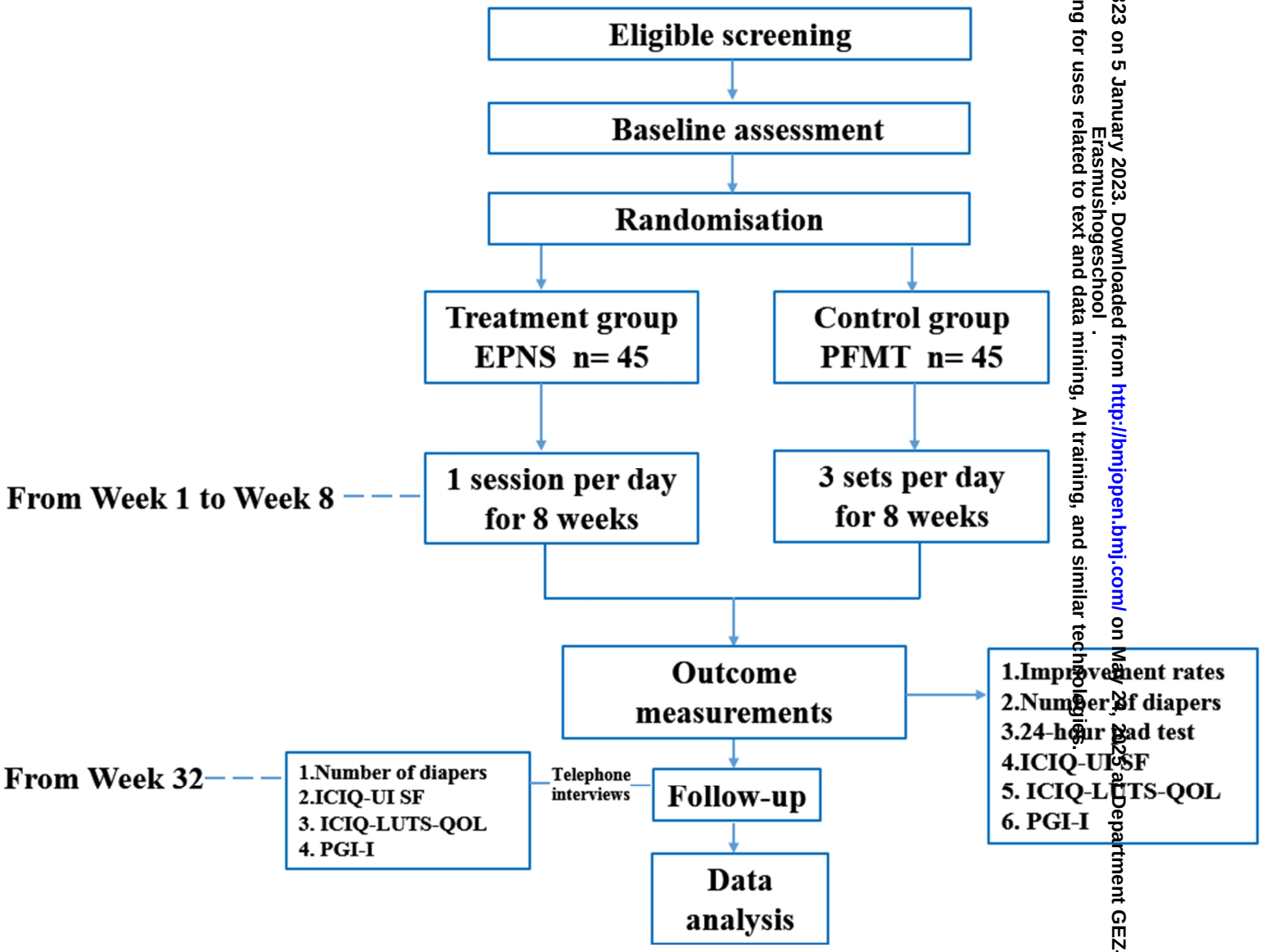
Figure 2. Diagnostic criteria of the scored urinary incontinence questionnaire.
The y-axis plots scores for the stress urinary incontinence (SUI; 0–26 points) and the x-axis plots scores for urge urinary incontinence (UUI; 0–26 points). Zone ‘a’ indicates an SUI score of 19–26 points and a UUI score of 0–6 points. Zones ‘a–c’ indicate SUI; ‘g’, ‘i’ and ‘j’ indicate UUI; and ‘e’, ‘f’ and ‘h’ indicate mixed urinary incontinence (MUI). Patients with SUI within zones ‘a-c’, and patients with stress-predominant MUI (zone ‘e’) will be included in the present protocol. Patients in zone ‘h’ has urgency-dominant symptoms and patients in zone ‘f’ has symptoms from both types of urinary incontinence without significant differences in predominance; they will not be included in the present protocol.

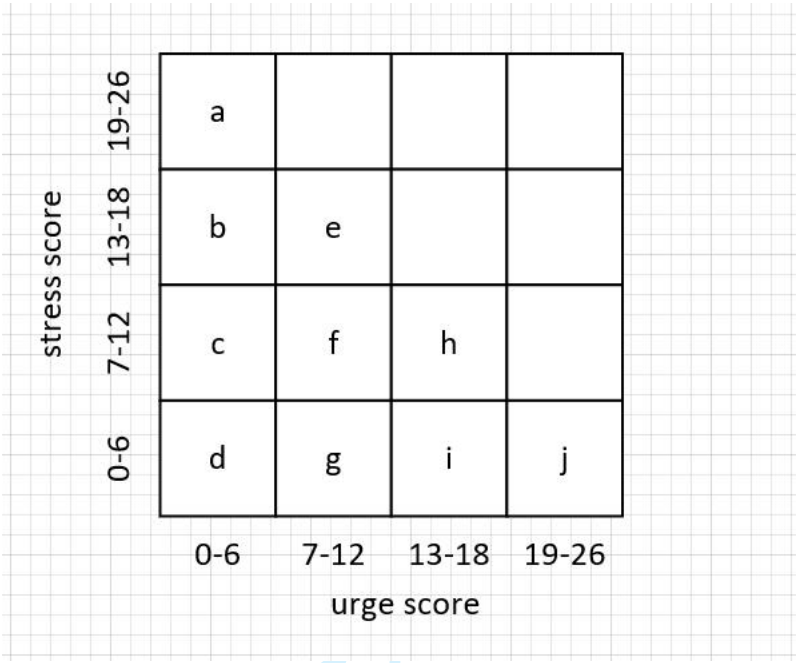
Figure 3. Location of the ‘four sacrococcygeal points’ for electrical pudendal nerve stimulation

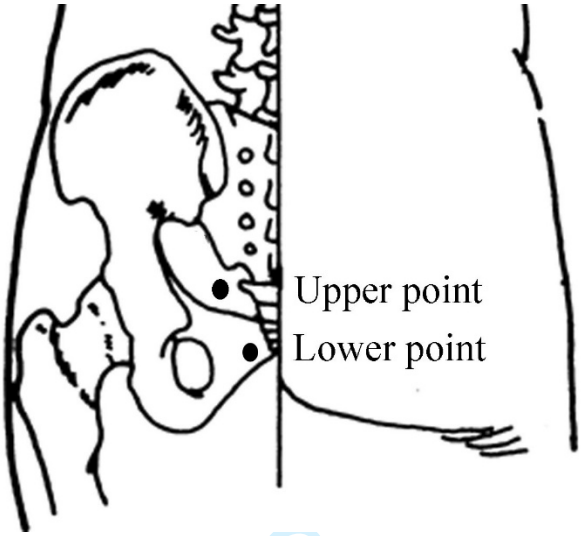
Figure 4. Anatomical positions of the ‘four sacrococcygeal points’ for electrical pudendal nerve stimulation

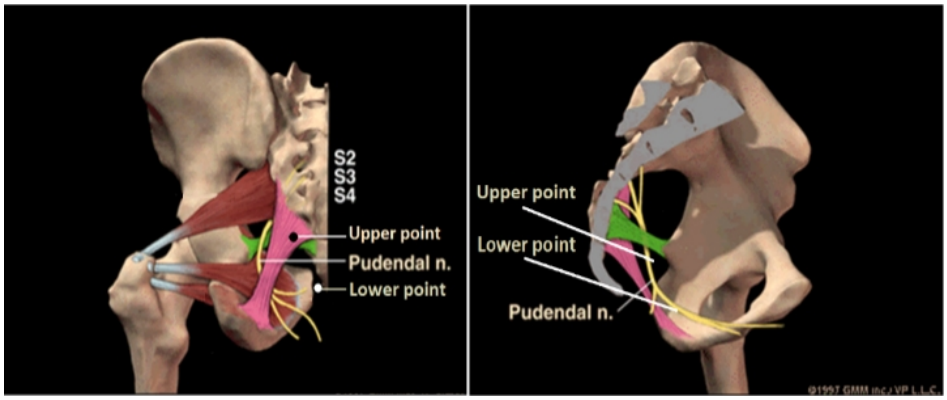
Figure 5. Transverse computed tomography image of the coccygeal apex.
The tip of the needle inserted at the lower sacral point is visible

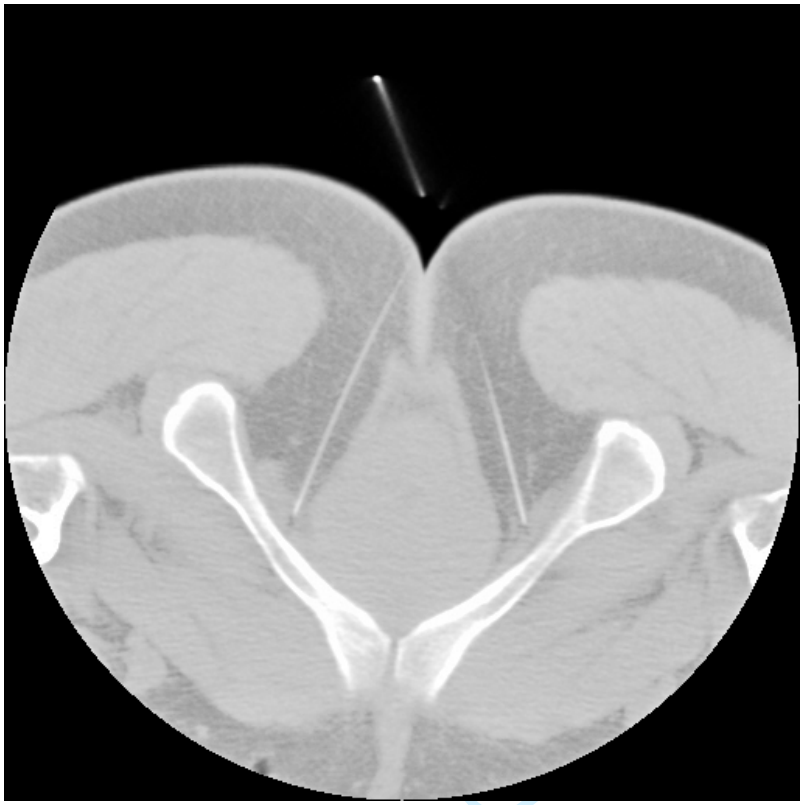
in the ischiorectal fossa (adjacent to the pudendal nerve in theAlcock's canal).











Supplementary Table 1. Urinary incontinence score questionnaire

		Stress-score	Urge-score
1.	How often do you experience urine leakage?		
	Rarely		
	Sometimes		
	Every day, many times a day		1
	Constantly		1
2.	On what occasions have you experienced leakage?		
	When coughing or sneezing	1	
	When sitting or lying down		1
3	How much urine leaked		
	Only a few drops to a small amount	1	
	A considerable amount		1
4	At what intervals do you go to the toilet to pass urine every day?		
	At 3-6-h intervals	3	
	At 1-2-h intervals		2
5	Do you go to the toilet to pass urine after falling asleep at night?		
	Never, or once a night	3	

	More than once a night or many times a night	3
6	Do you ever experience urine leakage when sleeping at night?	
	Never	1
	Often	1
7	When you feel urinary urgency, can you control it?	
	Yes, I can	
	Unless I go to the toilet soon (in 10-20 min), I leak urine	
	I cannot control it, and I leak urine.	3
8	Do you ever leak urine on the way to the toilet?	
	Never, or rarely	3
	Almost always	3
9	Do you ever leak urine because you feel sudden and strong urinary urgency and cannot control it?	
	Never	3
	Sometimes, or often	3
10	Can you stop and start voiding in the middle of the urination?	
	Yes, I can	1
	No, I cannot	2

11	After urination, do you have a feeling of residual urine (a feeling that there is urine left in the bladder)	
	No, I do not	1
	Yes, I do	1
12	Do you often feel such urinary urgency that you want to go to the toilet immediately?	
	No, never	0
	Yes, I do	3
	Yes, very often	2
13	Have you ever experienced childbirth?	
	Yes, I have	
	No, I have not	1
14	How do you feel about your urine leakage?	
	It sometimes troubles me or it does not bother me very much	1
	It troubles me very much	1
15	How much do you weigh?	
	I weigh less than 65 kg	
	I weigh 65kg or more	1

Supplemental Table 2. International Consultation on Incontinence Questionnaire - Urinary Incontinence Short Form (ICIQ-UI SF)

1. Please write your date of birth:	□□ □□ □□ Date Month Year	
2. To which gender identity do you most identify?	Female □ Male □	
3. How often do you leak urine? (Tick one box)		
	Never	□ 0
	About once a week or less often	□ 1
	Two or three times a week	□ 2
	About once a day	□ 3
	Several times a day	□ 4
	All the time	□ 5
4. We would like to know how much urine you think leaks. How much urine do you usually leak (whether you wear protection or not)? (Tick one box)		
	None	□ 0
	A small amount	□ 2
	A moderate amount	□ 4
	A large amount	□ 6
5. Overall, how much does leaking urine interfere with your everyday life? Please circle a number between 0 (not at all) and 10 (a great deal)		

0	1	2	3	4	5	6	7	8	9	10	
Not at all										A great deal	

ICIQ score: sum scores 3+4+5 □□

6. When does urine leak? (Please tick all that apply to you)

Never – urine does not leak	□
Before you can get to the toilet	□
When you cough or sneeze	□
When you are asleep	□
When you have finished urinating and are dressed	□
For no obvious reason	□
All the time	□

Supplemental Table 3. International Consultation on Incontinence Questionnaire - Lower Urinary Tract Symptoms Quality of Life (ICIQ-LUTS-QOL)

1. Please write your date of birth:	□□ □□ □□ Date Month Year
2. To which gender identity do you most identify?	Female □ Male □
3a. To what extent does your urinary problem affect your household tasks (e.g. cleaning, shopping, etc.) (tick one box)	
	Not at all □ 1 Slightly □ 2 Moderately □ 3 A lot □ 4
3b. How much does this bother you? Please ring a number between 0 (not at all) and 10 (a great deal) 0 1 2 3 4 5 6 7 8 9 10 Not at all A great deal	
4a. Does your urinary problem affect your job, or your normal daily activities outside the home?	
	Not at all □ 1 Slightly □ 2 Moderately □ 3 A lot □ 4
Please ring a number between 0 (not at all) and 10 (a great deal) 0 1 2 3 4 5 6 7 8 9 10 Not at all A great deal	

5a. Does your urinary problem affect your physical activities (e.g. going for a walk, run, sport, gym, etc.)?	Not at all	□ 1
	Slightly	□ 2
	Moderately	□ 3
	A lot	□ 4

5b. How much does this bother you?

Please ring a number between 0 (not at all) and 10 (a great deal)

0 1 2 3 4 5 6 7 8 9 10

Not at all A great deal

6a. Does your urinary problem affect your ability to travel?	Not at all	□ 1
	Slightly	□ 2
	Moderately	□ 3
	A lot	□ 4

6b. How much does this bother you?

Please ring a number between 0 (not at all) and 10 (a great deal)

0 1 2 3 4 5 6 7 8 9 10

Not at all A great deal

7a. Does your urinary problem limit your social life?	Not at all	□ 1
	Slightly	□ 2
	Moderately	□ 3
	A lot	□ 4

7b. How much does this bother you?

Please ring a number between 0 (not at all) and 10 (a great deal)

0 1 2 3 4 5 6 7 8 9 10

Not at all A great deal

8a. Does your urinary problem limit your ability to see/visit friends?

	Not at all	□ 1
	Slightly	□ 2
	Moderately	□ 3
	A lot	□ 4
8b. How much does this bother you? Please ring a number between 0 (not at all) and 10 (a great deal) 0 1 2 3 4 5 6 7 8 9 10 Not at all A great deal		
9a.Does your urinary problem affect your relationship with your partner?	Not applicable	□ 8
	Not at all	□ 1
	Slightly	□ 2
	Moderately	□ 3
	A lot	□ 4
9b. How much does this bother you? Please ring a number between 0 (not at all) and 10 (a great deal) 0 1 2 3 4 5 6 7 8 9 10 Not at all A great deal		
10a. Does your urinary problem affect your sex life?	Not applicable	□ 8
	Not at all	□ 1
	Slightly	□ 2
	Moderately	□ 3
	A lot	□ 4
10b. How much does this bother you?		

Please ring a number between 0 (not at all) and 10 (a great deal)

0 1 2 3 4 5 6 7 8 9 10

Not at all A great deal

11a. Does your urinary problem affect your family life?

- Not applicable □ 8
- Not at all □ 1
- Slightly □ 2
- Moderately □ 3
- A lot □ 4

11b. How much does this bother you?

Please ring a number between 0 (not at all) and 10 (a great deal)

0 1 2 3 4 5 6 7 8 9 10

Not at all A great deal

12a. Does your urinary problem make you feel depressed?

- Not at all □ 1
- Slightly □ 2
- Moderately □ 3
- A lot □ 4

12b. How much does this bother you?

Please ring a number between 0 (not at all) and 10 (a great deal)

0 1 2 3 4 5 6 7 8 9 10

Not at all A great deal

13a. Does your urinary problem make you feel anxious or nervous?

- Not at all □ 1
- Slightly □ 2
- Moderately □ 3

	A lot	□ 4
13b. How much does this bother you? Please ring a number between 0 (not at all) and 10 (a great deal) 0 1 2 3 4 5 6 7 8 9 10 Not at all A great deal		
14a. Does your urinary problem make you feel bad about yourself?	Not at all Slightly Moderately A lot	□ 1 □ 2 □ 3 □ 4
14b. How much does this bother you? Please ring a number between 0 (not at all) and 10 (a great deal) 0 1 2 3 4 5 6 7 8 9 10 Not at all A great deal		
15a. Does your urinary problem affect your sleep	Not at all Slightly Moderately A lot	□ 1 □ 2 □ 3 □ 4
15b. How much does this bother you? Please ring a number between 0 (not at all) and 10 (a great deal) 0 1 2 3 4 5 6 7 8 9 10 Not at all A great deal		
16a. Do you feel worn out/tired?	Never	□ 1

		Sometimes	□ 2
		Often	□ 3
		All the time	□ 4
16b. How much does this bother you? Please ring a number between 0 (not at all) and 10 (a great deal) 0 1 2 3 4 5 6 7 8 9 10 Not at all A great deal			
17a. Wear pads to keep dry?		Never	□ 1
		Sometimes	□ 2
		Often	□ 3
		All the time	□ 4
17b. How much does this bother you? Please ring a number between 0 (not at all) and 10 (a great deal) 0 1 2 3 4 5 6 7 8 9 10 Not at all A great deal			
18a. Be careful how much fluid you drink?		Never	□ 1
		Sometimes	□ 2
		Often	□ 3
		All the time	□ 4
18b. How much does this bother you? Please ring a number between 0 (not at all) and 10 (a great deal) 0 1 2 3 4 5 6 7 8 9 10			

Not at all A great deal		
19a. Change your underclothes when they get wet?	Never Sometimes Often All the time	□ 1 □ 2 □ 3 □ 4
19b. How much does this bother you? Please ring a number between 0 (not at all) and 10 (a great deal) 0 1 2 3 4 5 6 7 8 9 10 Not at all A great deal		
20a. Worry in case you smell?	Never Sometimes Often All the time	□ 1 □ 2 □ 3 □ 4
20b. How much does this bother you? Please ring a number between 0 (not at all) and 10 (a great deal) 0 1 2 3 4 5 6 7 8 9 10 Not at all A great deal		
21a Get embarrassed because of your urinary problem?	Never Sometimes Often	□ 1 □ 2 □ 3

All the time □ 4

20b. How much does this bother you?

Please ring a number between 0 (not at all) and 10 (a great deal)

0 1 2 3 4 5 6 7 8 9 10

Not at all A great deal

22 Overall, how much do urinary symptoms interfere with your everyday life?

Please ring a number between 0 (not at all) and 10 (a great deal)

0 1 2 3 4 5 6 7 8 9 10

Not at all A great deal

Supplemental Table 4 The 24-hour pad test procedure

A pad test will be carried out one time for each of you at baseline before your next follow-up visit. Same type of diapers will be provided free of charge to you at baseline and end-point assessments. Here are steps:
1. Change the diaper every 4–6 h during the daytime 2. Collect all diapers through the daytime and nighttime (A night pad is not required if you does not leak when you are having a sleep) and store them in an airtight bag. 3. Bring the bag to the clinic where the weighing will be performed.
Thank you for your help.

Supplemental Table 5 Global Impression of Improvement (PGI-I)

Circle the one number that best describes how your urinary incontinence is now, compared with how it was before you had the treatment.
1. Very much better
2. Much better
3. A little better
4. No change
5. A little worse
6. Much worse
7. Very much worse

Patient Consent Form

Clinical research project: Randomized controlled study of electrical pudendal nerve stimulation therapy for urinary incontinence after radical prostatectomy

Clinical research unit: The First Affiliated Hospital of Zhejiang Chinese Medical University

Ethical approval number: 2021-KL-040-02

Declaration of Consent

I have read the above description of the study and have had the opportunity to discuss it with the doctor and ask questions about it.

All my questions have been answered satisfactorily.

I am aware of the risks and benefits that may arise from participating in this study.

I understand that participation in the study is voluntary, I confirm that I have had ample time to consider it, and understand that:

(1) I can always consult the doctor for more information.

(2) I can withdraw from the study at any time without discrimination or retaliation, and my medical treatment and rights and interests will not be affected.

I also know that if I withdraw from the study, especially when I withdraw from the study due to medication, it will be beneficial for me and the whole study if I tell the doctor about the change of my condition and complete the corresponding physical and physical examination.

If I need to take any other medication due to a change in my condition, I will consult my doctor beforehand or tell my doctor truthfully afterwards.

I consent to the Ethical Committee or the sponsor's representative and the study quality control personnel to have access to my study data.

I consent □ or refuse □ to use my medical records and pathological specimens for any study other than this study.

I will obtain a signed and dated copy of the informed consent form.

Finally, I decided to agree to participate in the study.

Subject's Signature:_____Date: __ __ __ __ Year _ _ month _ _ day

Contact Number:_____Mobile Phone Number:_____

Signature of legal representative (if any):_____

I confirm that I have explained to the patient the details of this study, including his rights and possible benefits and risks, and provided him with a copy of the signed informed consent form.

Investigator's signature: Date: __ __ __ __ Year _ _ month _ _ day

Work Phone:_____ Mobile Phone Number:_____

Ethics Committee Office of the First Affiliated Hospital of Zhejiang Chinese Medical University

0571-87072953/87013311

Section/item	ItemNo	Description	
Administrative Information			
Title	1	Efficacy of electrical pudendal nerve stimulation versus pelvic floor muscle training in treating post-radical prostatectomy urinary incontinence: study protocol for a randomised controlled trial[1]	
Trial registration	2a	ChiCTR2200055461[2]	
	2b	Primary registry and trial identifying number	ChiCTR2200055461
		Date of registration in primary registry	10 Jan 2022
		Secondary identifying numbers	
		Source(s) of monetary or material support	Zhejiang Provincial Administration of Traditional Chinese Medicine
		Primary sponsor	Zhejiang Provincial Administration of Traditional Chinese Medicine
		Secondary sponsor(s)	
		Contact for public queries	SYW[wangsiyou1234@163.com]
		Contact for scientific queries	SYW Clinical Research Section, Shanghai Research Institute of Acupuncture and Meridian, Shanghai, China
		Public title	Efficacy of electrical pudendal nerve stimulation versus pelvic floor muscle training in treating post-radical prostatectomy urinary incontinence

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Scientific title	Efficacy of electrical pudendal nerve stimulation versus pelvic floor muscle training in treating post-radical prostatectomy urinary incontinence: study protocol for a randomised controlled trial
Countries of recruitment	China
Health condition(s) or problem(s) studied	Electrical pudendal nerve stimulation; Urinary incontinence after radical prostatectomy
Intervention(s)	Treatment group: electrical pudendal nerve stimulation (EPNS) Control group: pelvic floor muscle training (PFMT)
Key inclusion and exclusion criteria	Ages eligible for study: 45-80 years old; Sexes eligible for study: male; Accepts healthy volunteers: no. Inclusion criteria [6] Incontinence at 1 month or more after RP; Symptoms of UI after RP with a positive 24-hour pad test; Fulfilment of the diagnosticcriteria for SUI or stress-predominant mixed urinary incontinence (MUI); No residual cancer after RP on pathological examination Exclusion criteria: [6] Urge-predominant mixed UI; Overflow UI; UI prior to surgery or UI caused by comorbidities, such as Parkinson's disease, multiple sclerosis, spinal cord injury, Alzheimer's disease, and diabetes mellitus; Undergoing or had prior radiation therapies; Difficulty in voiding; Urethral stricture, urinary tract obstruction, bladder neck obstruction, refractory urinary tract infection,

			hydronephrosis, urinary calculi or tumours;Use of medications that affect bladder function (e.g., antimuscarinics or beta-3 agonists); Severe insufficiency in vital organs, such as the heart, lungs, liver, and kidneys.
		Study type	Interventional Allocation: randomized; Intervention model: parallel assignment; Masking: blinded assessment and analysis. Primary purpose: treatment
		Date of first enrolment	3 Mar 2022
		Target sample size	90
		Recruitment status	Recriuting
		Primary outcome(s)	Improvement rate[10-11]
		Key secondary outcomes	number of urinary pads required, 24-hour pad test, International Consultation on Incontinence Questionnaire Urinary Incontinence – Short Form (ICIQ-UI SF)[10-11]
Protocol version	3	Issue date: 10 Jan 2022	
		Protocol amendment number: 01	
		Authors: Shan Chen, Siyou Wang, Shan Liu,Shenhong Wang，Lihua Xuan, Yunqiu Cao	
Funding	4	This work has been supported Zhejiang Provincial Administration of Traditional Chinese Medicine (grant number 2021ZA056)[17]	
Roles and responsibilities	5a	SC [Department of Acupuncture and Moxibustion, the First Affiliated Hospital of Zhejiang Chinese Medical University, Hangzhou, China]; SYW[Clinical Research Section, Shanghai Research Institute of Acupuncture and Meridian, Shanghai, China]; SL[Clinical Evaluation and Analysis Center of the First Affiliated Hospital of Zhejiang Chinese Medical University, Hangzhou, China]; SHW[Department of Urology, the First Affiliated Hospital of Zhejiang Chinese Medical University, Hangzhou, China];	

		LHX[Department of Acupuncture and Moxibustion, the First Affiliated Hospital of Zhejiang Chinese Medical University, Hangzhou, China]; YQG[Department of Urology, the First Affiliated Hospital of Zhejiang Chinese Medical University, Hangzhou, China][1] Contributors: SC conceived the study and developed the protocol; SYW and YQG contributed to the study design; SL contributed to the sample size calculation and planned the statistical analysis; and LHX and SHT prepared the flowchart, figures, and tables. All authors have read and approved the final manuscript.[17]
	5b	Trial sponsor: Zhejiang Provincial Administration of Traditional Chinese Medicine [17]
		Sponsor's Reference: grant number 2021ZA056 [17]
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		Telephone: +86 0571 8770 9076
		Email: zjtcm@zjwst.gov.cn
	5c	This funding source had no role in the design of this study and will not have any role during its execution, analyses, interpretation of the data, or decision to submit results.
	5d	Authors in the title page are members of the steering committee
Introduction		
Background and rationale	6a	Introduction: Urinary incontinence (UI) is one of the main complications of radical prostatectomy (RP).The incidence of post-radical prostatectomy UI (PPUI) ranges from 5% to 70%, with the incidence of UI at 12 months postoperatively exceeding 20%. Besides posing a heavy economic burden, UI also has a considerable negative impact on the social life and interpersonal relationships of patients. Stress urinary incontinence (SUI) is the main type of PPUI; however, there are currently no recommended pharmacological agents for the non-surgical treatment of PPUI. At present, PFMT is the most widely used approach for treating PPUI. Although PFMT enables the strengthening of pelvic floor muscles, many patients find it difficult to perform the training

		correctly. In addition, the relatively long treatment duration makes it difficult for patients to persist with PFMT in the long term, ultimately resulting in poor treatment adherence. Transanal electrical stimulation is a non-invasive, passive method of pelvic floor muscle training that enhances patient adherence. However, its effects are indirect in nature, owing to the use of surface electrodes. A study comparing the effects of PFMT alone and in combination with transanal electrical stimulation for the treatment of PPUI reported that although both regimens improved UI, the difference in their effects was not statistically significant.[4] EPNS is a novel technique for the treatment of SUI. In previous studies, we used computed tomography in the transverse plane with simultaneous pelvic floor measurements to demonstrate that EPNS enabled pelvic floor muscle contraction and was effective in treating female SUI and urge incontinence. In a recent study, we used simultaneous measurements of movement and surface electromyography of the pelvic floor muscles in male subjects to show that EPNS promoted the contraction and strengthening of pelvic floor muscles and the simulation of PFMT, thus leading to the effective treatment of PPUI.[4-5] Treatment period: All participants will receive one session every day from Monday to Friday. The therapeutic effects will be evaluated after the completion of 40 sessions (8 weeks).[9-10]
	6b	Compared with active PFMT, EPNS can provide highly effective passive training for the pelvic floor muscles. This can help address the difficulties faced by patients in correctly locating the pelvic floor muscles and persisting with PFMT, thus improving overall patient adherence. However, across studies, there are significant differences in the indicators and assessment techniques for determining the degree of UI, and the long-term efficacy of EPNS for treating PPUI has not been reported. In addition, although it is known that EPNS can simulate PFMT, there are no studies comparing the effects of EPNS and PFMT in the treatment of PPUI.[4-5]
Objectives	7	Here we describe a protocol for an RCT to evaluate the long-term efficacy of EPNS in treating PPUI through the establishment of a PFMT control group and adoption of comprehensive assessment criteria and indicators.[5]
Trial design	8	It is designed as a blinded randomized assessment and analysis with two parallel groups over an 8-week treatment period. Randomization will be performed in a random 1:1 allocation sequence.[5]
Methods: Participants, interventions, and outcomes		

Study setting	9	Eligible patients with UI after RP will be recruited from the inpatient and outpatient departments (mainly the Acupuncture and Moxibustion and Urology departments) of the First Affiliated Hospital of Zhejiang Chinese Medical University according to the inclusion and exclusion criteria.[5]
Eligibility criteria	10	Inclusion criteria:[6] 1.Incontinence at 1 month or more after RP; 2.Symptoms of UI after RP with a positive 24-hour pad test; 3.Fulfilment of the diagnostic criteria for SUI or stress-predominant mixed urinary incontinence (MUI); 4.No residual cancer after RP on pathological examination Exclusion criteria: [6] 1.Urge-predominant mixed UI; 2.Overflow UI; 3.UI prior to surgery or UI caused by comorbidities, such as Parkinson's disease, multiple sclerosis, spinal cord injury, Alzheimer's disease, and diabetes mellitus; 4.Undergoing or had prior radiation therapies; 5.Difficulty in voiding; 6.Urethral stricture, urinary tract obstruction, bladder neck obstruction, refractory urinary tract infection, hydronephrosis, urinary calculi, or tumours; 7.Use of medications that affect bladder function (e.g., antimuscarinics or beta-3 agonists); 8.Severe insufficiency in vital organs, such as the heart, lungs, liver, and kidneys.
Interventions	11a	Treatment group:[8] Acupoint selection: We select 4 specific acupoints in the sacrococcygeal region (that is, the “four sacrococcygeal points”). Upper acupuncture needles will be inserted at points located 1 cm from the sacrococcygeal joint (bilaterally symmetrical), and lower

acupuncture needles will be inserted at points located 1 cm from the apex of the coccyx (bilaterally symmetrical)

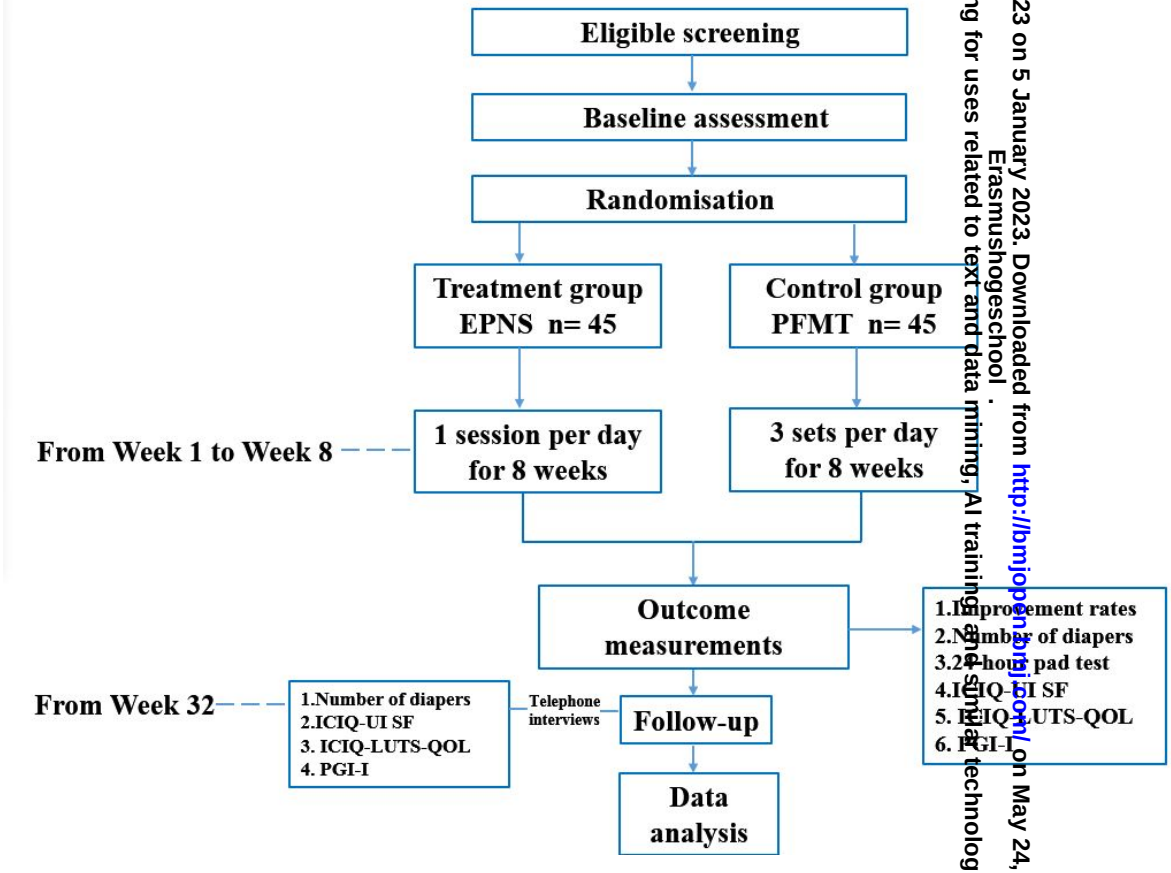
Key points of the EPNS process: EPNS will be performed using long acupuncture needles (0.4 mm × 100 mm, Suzhou Shenlong Medical Apparatus Factory, Suzhou, China) on patients lying in the prone position. The upper needles will be inserted vertically to a depth of 75–90 mm for the transmission of needle sensations to the urinary tract organs, and the lower needles will be inserted diagonally towards the lateral side (in the direction of the ischiorectal fossa) to a depth of 90–95mm for the transmission of needle sensations to the perineum (penile root).When the needle sensations have reached the aforementioned body parts, the handles of the needles on each side will be connected to a pair of electrodes on a G6805 electroacupuncture apparatus ((Shantou Medical Equipment Factory Co. Ltd., Shantou, China) , with the cathode connected to the upper needle and anode connected to the lower needle. Electrical stimulation will be performed using continuous waves at a frequency of 2.5 Hz (150 times/min) and the highest possible intensity (45–55 mA) that the patient can tolerate without experiencing discomfort. Each stimulation session will last for 1 h, and a rhythmic sensation of strong contractions in the upward (cranial) direction centred around the penile root must be maintained in the pelvic floor muscle throughout the electro-acupuncture session.

Control group:[8-10]

Patients in the control group will perform PFMT by doing the Kegel exercise.[8,10]A physiotherapist will provide guidance for training, explain pelvic floor muscle contraction, and give the instructions like "stop the flow of urine and shorten the penis while continuing to breathe".[21]A digital anal examination using the Oxford score (graded 0–5) will be applied by the therapist when giving instructions and will be communicated with the patients by verbal feedback.[22] Patients scoring at least Grade 2 will be determined whether they can finish a correct contraction. Otherwise, the patient will be taught again until the technique has been performed correctly. Once the patients' abilities are known, they will be required to contract the pelvic floor muscles as much as possible for 3–10 s, depending on their ability and subsequently relax the muscles for an equal period of time. The contraction–relaxation cycle is to be repeated 15 times to form a set, and patients will be required to complete three sets daily in three positions (in supine, sitting and standing, each for one position) after RP at home. In addition, a written training diary (Table 1) will be given to the patients for ongoing training for 8 weeks. The physiotherapist will pay a one-time office visit when the

		participants are recruited at baseline assessment interview on the PFMT technique and will continue with 24 times of online visits through WeChat (a social media mobile app) or phone calls (a few older people do not know how to use smartphones) three times a week for better execution of PFMT at home. Treatment period: Eight weeks.
	11b	Dropout criteria[10] 1. Poor participant compliance (lack of adherence to treatment for personal reasons). 2. Serious adverse events (SAE), complications, or special physiological changes necessitating discontinuation of the intervention. 3. Voluntary dropout.
	11c	The physiotherapist will pay a one-time office visit when the participants are recruited at baseline assessment interview on the PFMT technique and will continue with 24 times of online visits through WeChat (a social media mobile app) or phone calls (a few older people do not know how to use smartphones) three times a week for better execution of PFMT at home.[10] Here in our study we adopt Wechat, a social media mobile app, to provide a supervised PFMT through dedicated physiotherapy in clinical trial. [16]
	11d	Fluid intake of patients in both groups will also be advised by clinicians during the 8-week trial time, recommending six glasses (approximately 1,200–1,500 mL) of fluid to take during the day and informing them to avoid having coffee, tea, or alcohol, which may induce an increased risk of leakage.[10]
Outcomes	12	Primary outcome measures [10-11] Improvement rate has been set as the primary indicator. Scores for the number of urinary pads required, the 24-hour pad test, and responses to the ICIQ-UI SF will be summed to form the total score for each patient and the improvement rate will be calculated using the following formula: Improvement rate (%)=[(total score before treatment— total score after treatment)÷total score before treatment]×100 Treatment will be deemed effective when the improvement rate exceeds 25%. Secondary outcome measures[10-11] 1.Number of urinary pads used: scores will be awarded based on the number of urinary pads required

		2.24-hour pad test 3. International Consultation on Incontinence Questionnaire Urinary Incontinence – Short Form (ICIQ-UI SF) Number of urinary pads used and 24-hour pad test are widely used in clinical practice to assess the severity of UI symptoms. The ICIQ-UI SF is a brief and psychometrically robust patient-completed questionnaire for evaluating the frequency and severity of UI in men and women and its impact on quality of life (QoL). The ICIQ-UI SF score ranges from 0 to 21. The above outcome measures will be assessed at baseline and at 8 and 32 weeks after baseline.
Participant timeline	13	The study will be conducted in the First Affiliated Hospital of Zhejiang Chinese Medical University (one of the tertiary hospitals in China) from 10 January, 2022, and will end on 31 December 2023. All procedures and time frames are presented in Figure 1. A treatment period of 8 weeks and a follow-up period of 32 weeks will follow the recruitment procedure.[5] Figure1



Sample size	14	Referring to a previous study with 96 patients (efficacy rate 68.7%:34.4%), the required sample size was calculated using the Power Analysis and Sample Size 15 software (NCSS Statistical Software, UT, USA). A sample size of 40 patients was determined to have a power (1-beta) of 0.90, an alpha (significance level) of 0.05, and a ratio of 1:1. Taking potential dropouts (10% of the participants) into account, the total sample size was increased to 90 in total (45 in each group).[7]
Recruitment	15	Eligible patients with UI after RP will be recruited from the inpatient and outpatient departments (mainly the Acupuncture and Moxibustion and Urology departments) of the First Affiliated Hospital of Zhejiang Chinese Medical University according to the inclusion and exclusion criteria. Advertisements will be displayed in health education brochures and posters on the website of the First Affiliated Hospital of Zhejiang Chinese Medical University. At the beginning of recruitment, detailed information about the study, including the research objective, study procedure, and potential benefits and risks, will be provided to all eligible patients. Recruitment information will also be released through media, such as websites and mobile phone applications. A written informed consent form will be given to patients who agree to participate. Once the consent form is signed, the patient will be included for baseline evaluation and randomization.[5-6]
Methods: Assignment of interventions		
Administrative Information		
Allocation:		
Sequence generation	16a	The randomisation will be performed by the Clinical Evaluation and Analysis Centre of the First Affiliated Hospital of Zhejiang Chinese Medical University. A random 1:1 allocation sequence will be generated through Statistical Package for the Social Sciences (SPSS) software (v.26.0; Chicago, IL, USA).[7]
Allocation concealment mechanism	16b	Professionals involved in the allocation will not be recruited in the study. The random allocation will be strictly kept in an opaque, sequentially numbered envelope that is inaccessible to other research staff. After baseline assessment, the envelope will be opened by an independent staff member in the presence of the participants, who will be assigned into either the treatment or control group.[7]
Implementation	16c	Randomisation will be requested by the staff member responsible for recruitment and clinical interviewers from the First Affiliated

		Hospital of Zhejiang Chinese Medical University, who are not allowed to receive information about the group allocation.[7]
Blinding	17a	In this study, participants and acupuncturists will not be blinded due to the nature of acupuncture. Data analysts will be blinded to the participant's allocation throughout the trial. Telephone interviewers who collect follow-up information will also be blinded. Acupuncturists will not be permitted to communicate with any data analysts or telephone interviewers. [7-8]
	17b	If an unblinding event occurs among data analystsor telephone interviewers, the relevant work will be transferred to other appropriately blinded research staff. The revealing of allocation will only be permitted when it is needed for final comparison between the treatment and control groups.[7-8]
Methods: Data collection, management and analysis		
Data collection method	18a	The baseline data and assessment information of all participants will be collected by a trained assistant who is blinded to treatment group allocation. The participants will be required to provide the number of pads used for UI, complete the 24-hour pad test, and respond to the ICIQ-UI SF and ICIQ-LUTS-QOL at baseline and after 8 weeks. PGI-I will be provided after 8-week intervention. An independent blinded researcher will conduct telephone interviews of all participants to collect the number of pads they used and, ICIQ-UI SF score, ICIQ-LUTS-QOL score, and PGI-I at 32 weeks after baseline. All data will be recorded on the CRFs.[12] Upon the completion of the CRFs, including intervention and follow-up, all the participants' data will be entered into an Excel spreadsheet by two independent researchers blinded to the group allocation. An independent supervisor will check the two datasets for accuracy. If inconsistencies are discovered, the supervisor will compare the datasets with the original CRFs and mark the modifications on the CRFs. [12]
	18b	If a participant discontinues treatment early, their final evaluation data will be collected and used in the analysis.[12]
Data management	19	The First Affiliated Hospital of Zhejiang Chinese Medical University will be responsible for the storage and management of all documents.[12]
Statistical methods	20a	A statistician from the Clinical Evaluation and Analysis Centre of the First Affiliated Hospital of Zhejiang Chinese Medical University will perform all statistical analyses using SPSS Statistics (v.26.0). A normality test will be used to determine whether the

		data are normally distributed. If there is an imbalance in the baseline characteristics and outcome measures, analysis of covariance will be used. Continuous variables with a normal distribution will be reported as mean ± standard deviations, and those with a non-normal distribution or ordinal variables will be expressed as medians (with lower and upper quartiles). Counts and proportions will be expressed for categorical variables. The last observation carried forward method will be used to process the missing data. For the primary outcome measures, Student's t-tests will be used to analyse normally distributed data. A paired t-test will be used to compare pre-treatment and post-treatment improvement rates. An independent sample t test will be used to compare improvement rates between the two groups. For non-normally distributed data, a Mann–Whitney U test will be used for between-group comparison, and a Wilcoxon signed rank test will be used to compare pre-treatment and post-treatment improvement rates. Differences between the two groups will be compared by the inter-group rank sum test.[13] The secondary outcome measures—including scores for the number of pads used in the 24-hour pad test, and responses to the ICIQ-UI SF—will be analysed following the same methods as those used to analyse the primary outcome measures. All reported P-values will be two-tailed, and confidence intervals will be at the 95% level. A P-value of <0.05 will be considered statistically significant.[14] The quality of life and satisfaction outcomes, ICIQ-LUTS-QOL score and PGI-I score will be analysed following the same methods.[14]
	20b	If there is an imbalance in the baseline characteristics and outcome measures, analysis of covariance will be used.[13]
	20c	The last observation carried forward method will be used to process the missing data.
Methods: Monitoring		
Data monitoring	21a	Members of the Clinical Evaluation and Analysis Centre of the First Affiliated Hospital of Zhejiang Chinese Medical University will organize an independent data monitoring committee who are blinded to the treatment allocations and will meet regularly to monitor the study data.[13]
	21b	When half of the patients have been randomised and have completed the primary outcome measurement, interim analysis will be

		performed by the data monitoring committee.[13]
Harms	22	Adverse events (AEs) An adverse event (AE) of acupuncture will be assessed according to its severity based on local reactions, such as subcutaneous haematoma, subcutaneous bruise, regional muscle spasm, regional pain, regional skin allergy, and infection, or systemic reactions, such as fainting, abdominal distention, vertigo, fatigue, systemic allergy, systemic infection, and organ injury. Systemic infection and organ injury will be considered severe AEs. The level of severity, time of occurrence, and corresponding management will be recorded on the Case Report Forms (CRFs). All the acupuncturists and research staff will be trained to deal with AEs, and severe AEs will be reported to the Ethics Committee within 24 h. The Ethics Committee will also decide the necessity for withdrawal of the participant from the trial.[11]
Auditing	23	The First Affiliated Hospital of Zhejiang Chinese Medical University will audit this study mainly for participant enrolment, consent, and financial costs.[13]
Ethics and dissemination		
Research ethics approval	24	Research ethics approval The Ethics Committee of the First Affiliated Hospital of Zhejiang Chinese Medical University has reviewed and approved this protocol (approval no. 2021-KL-040-02). This study will adhere to the principles of the Declaration of Helsinki.[14]
Protocol amendments	25	Modification of the protocol Any modifications to the protocol, including changes of study objectives, study design, patient population, sample sizes, study procedures, or significant administrative aspects, will require a formal application to the Zhejiang Provincial Administration of Traditional Chinese Medicine as well as the Chinese clinical trial registry.
Consent or assent	26a	At the beginning of recruitment, detailed information about the study, including the research objective, study procedure, and potential benefits and risks, will be provided to all eligible patients. If the patient agrees to participate, he will be asked to sign a written informed consent form.[5-6]

	26b	There are no additional consent provisions for collection and use of participant data and biological specimens in ancillary studies.
Confidentiality	27	Each study participant will be assigned an identification number throughout the trial to assure confidentiality.
Declaration of interests	28	None.
Access to data	29	All the original documents (papers or electronic files) will be accessible only to the principal investigator of the research team.[12]
Ancillary and post-trial care	30	Patients having local adverse reactions will be given medical care to ease the bleeding, irritation, and bruising. Those having severe reactions leading to organ injury, systematic infection, and systematic allergy will be given compensation by our research team to cover their medical costs.[12]
Dissemination policy	31a	At the end of this trial, the results of this study will be disseminated in peer-reviewed journals and at academic conferences.[14]
	31b	SC conceived the study and developed the protocol; SYW and YQG contributed to the study design; SL contributed to the sample size calculation and planned the statistical analysis; and LHX and SHW prepared the flowchart, figures, and tables. All authors have read and approved the final manuscript.[17]
	31c	A brief plain language summary of the results will be displayed for the patients on a website (https://sandychenshan.haodf.com/) and on BiliBili (a video sharing mobile phone application).[14]
Appendices		
Informed consent materials	32	A model consent form have been made and provided to the Ethics Committee of the First Affiliated Hospital of Zhejiang Chinese Medical University
Biological specimens	33	We collect pads from PPUI patients and dispose them immediately once the weighing of 24-hour-pad test is done.