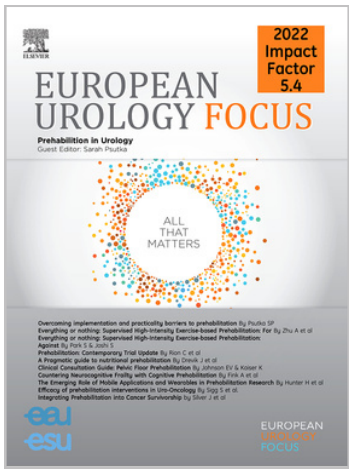
tensi+

New TENSI+ Device for Transcutaneous Posterior Tibial Nerve Stimulation: A Prospective, Multicentre, Post-market Clinical Study

Jean-Nicolas Cornu , Laurence Donon, Caroline Thullier, François Meyer, Julia Klap, Sandrine Campagne-Loiseau, Akshaya Mariadassou, Benoit Peyronnet



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Success rate: 67%. After 3 months.

- Prospective and multicentre study
- **78** patients
- Effectiveness in 67% of patients after **3 months** of treatment:
  - **significant decrease** in OAB symptoms
  - **high satisfaction** with health improvement (PGI-I).
- **88% of patients** rated their experience with the Tensi+ device as positive

Stimuli TECHNOLOGY

ISO 13485:2016

A prospective and multicentre study

Study objective: to confirm the effectiveness and safety of the Tensi+ medical device in the treatment of overactive bladder.

Primary endpoints:
Evaluate the **effectiveness of Tensi+ treatment** on OAB at 3 months:

- by demonstrating at least a 30% reduction in symptoms (urgency, pollakiuria, urinary incontinence (UUI episodes)) on the 3-month mictional diary compared with the baseline bladder diary.

- by obtaining a score **≤ 3 on the PGI-I questionnaire** (score 1 corresponding to “much better”; score 2 corresponding to “better”; score 3 corresponding to “slightly better”).

Secondary endpoints:

- Assessment of treatment tolerance up to **6 months.**
- Evaluation of the evolution of clinical parameters of the **mictional diary**.
- Assessment of **quality of life**.

Number of patients: 78 patients

Study period: 6 months (a first visit at 3 months post-inclusion and a second visit at 6 months post-inclusion)

Results and conclusion:

- **Treatment was effective for 67% of patients after 3 months of treatment:**
  - significant reduction in OAB symptoms (bladder diary)
  - high satisfaction with health improvement (PGI-I).

- **43 patients continued treatment up to 6 months.**

- Results confirm **long-lasting effectiveness** of treatment, with symptom, **quality of life** and **satisfaction scores** comparable to 3-month data;

- The results of the PGI-I questionnaire revealed that 38 patients maintained **satisfaction with scores of 1, 2 and 3.**

- **88% of patients rated their experience with the Tensi+ device as positive,** particularly in terms of **usability, adaptability and reliability.**

Tensi+ proved **its effectiveness in the management of OAB** in both sexes, with an excellent safety profile.

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Female Urology - Incontinence

New TENSI+ Device for Transcutaneous Posterior Tibial Nerve Stimulation: A Prospective, Multicentre, Post-market Clinical Study

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Abstract

Background and objective: Our aim was to report the first clinical trial of TENSI+, a new device for transcutaneous posterior tibial nerve stimulation (TNS) for treatment of overactive bladder (OAB).

Methods: A prospective, multicentre clinical trial was conducted in adults with OAB in seven French centres. The main exclusion criteria were prior percutaneous or transcutaneous TNS or invasive OAB treatment, current antimuscarinic use, 24-h polyuria, known bladder disease, postvoid residual volume >150 ml, and pelvic organ prolapse stage >2. Patients self-administered daily TTNS sessions of 20 min with TENSI+ at home after education by a specialized nurse. A bladder diary, Urinary Symptom Profile and OAB-q questionnaires, and Patient Global Impression of Improvement (PGI-I) scores were evaluated at baseline and 3 and 6 mo. The primary endpoint was efficacy, based on PGI-I and variations in bladder diary parameters. Success was defined as a PGI-I score $\leq$3 and any improvement $\geq$30% in bladder diary parameters.

Key findings and limitations: The study included 78 patients (13 males). Nine patients had neurological disease, 21 had previously tried antimuscarinics, and 41 had wet OAB at baseline. At 3 mo, 65/78 patients had a full analysis set. Treatment was successful in 44/65 patients (67%), with 25/65 (38%) reporting both an objective improvement and high satisfaction. All OAB-related endpoints were significantly improved, except bladder capacity and total voided volume per 24 h. At 6 mo, only five of 44 patients had interrupted their treatment. No factor predictive of success was identified. Two adverse events (pain at stimulation site and/or pelvic pain) were reported and spontaneously resolved without treatment interruption.

Conclusions and clinical implications: TENSI+ is a safe and effective TTNS treatment option for OAB management.

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Patient summary: TENSI+ is a new device for nerve stimulation in patients with overactive bladder. Patients use the device at home every day. In our short-term trial, TENSI+ use improved symptoms in 67% of patients. Further evaluation over a longer period of time is needed.

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1. Introduction

Overactive bladder (OAB) is a symptom complex defined as urinary urgency, usually accompanied by frequency and nocturia, with or without urge urinary incontinence (UUI), if there is no proven infection or other obvious pathology [1–3]. OAB prevalence is 10–15% in both sexes, and increases with age [4,5]. OAB may be of neurogenic or non-neurogenic origin, and several underlying mechanisms have been described [6]. First-line therapeutic interventions include lifestyle changes, physiotherapy, acupuncture, and electric stimulation. If conservative measures fail, medications such as anticholinergic and β3-adrenergic agents are recommended [7]. Third-line treatments include botulinum toxin injection, sacral neuromodulation, and invasive bladder surgery [7].

Tibial nerve stimulation (TNS) is recognized as a valuable, safe, and effective first-line option and is recommended by the most recent European Association of Urology guidelines [7–10]. TNS can be administered via two routes: percutaneous TNS (PTNS) or transcutaneous TNS (TTNS). The efficacy of the historical percutaneous approach has been demonstrated in comparison to anticholinergics and placebo/sham treatment, but PTNS is more invasive than TTNS [11–13]. It has been demonstrated that TTNS is noninferior to PTNS and better than sham treatment [14–17] and its use is expanding.

TENSI+ is a newly released TTNS device marketed for OAB management [18]. Our objective was to prospectively assess its efficacy and safety for OAB management in adults. Our main hypothesis was that TENSI+ use would lead to an improvement in OAB symptoms in >50% of cases.

2. Patients and methods

2.1. Study design and patient inclusion

A multicentre, prospective study was conducted in France. Seven study sites were involved, with the possibility to include up to 20 patients per site. All adult patients with OAB symptoms could be screened, and the objective was to include consecutive eligible patients. Exclusion criteria were pregnancy; an active implantable device or ankle orthopaedic implant; ankle articular diseases; prior PTNS or TTNS treatment, sacral neuromodulation, intradetrusor botulinum toxin injection within the previous 6 mo; antimuscarinic use within the previous month; 24-h diuresis >2800 cm^3; known bladder disease; active urinary tract infection, postvoid residual volume (PVR) >150 ml; pelvic organ prolapse stage >2; predominant stress urinary incontinence; cognitive impairment; inability to use the device without a third party; inability to complete a bladder diary; and no health insurance coverage. Written informed consent was mandatory. After inclusion, patients were prescribed TTNS therapy with the TENSI+ device (Stimuli Technology, Boulogne Billancourt, France [19]) for 3 mo, and 6 mo in cases of treatment persistence (Fig. 1).

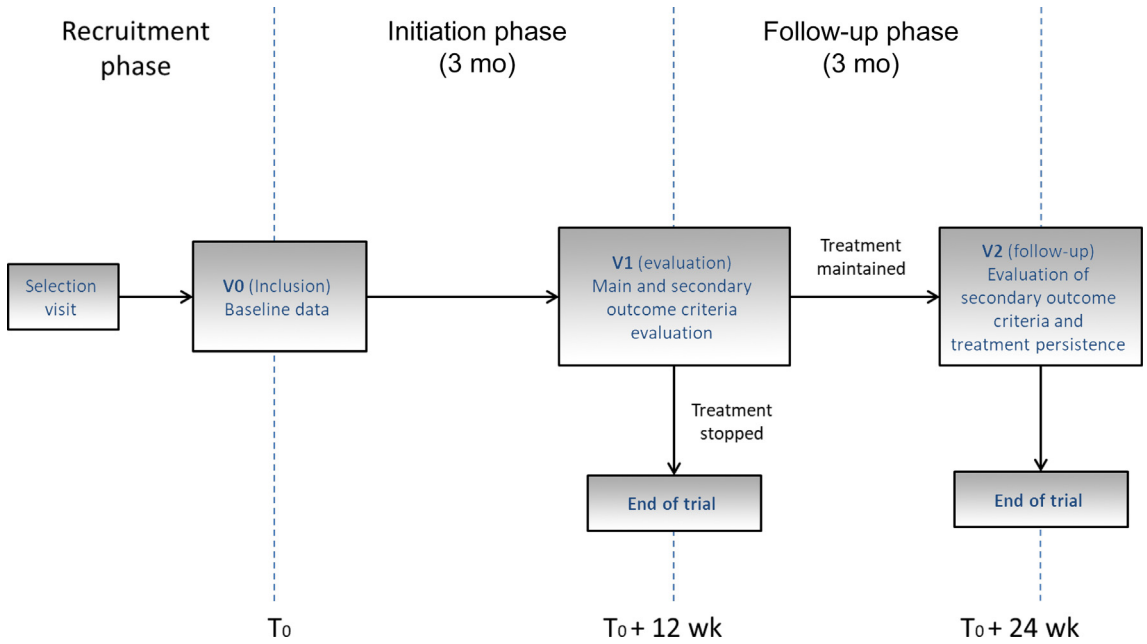

Fig. 1 – Study design.

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2.2. Treatment

Within 14 d after TENSI+ prescription, a nurse affiliated to an external homecare provider delivered the device directly to the patient during a specific education visit. Patients were instructed to use the device daily for 20 min via self-administration until the 3-mo visit. Stimulation settings are preset at a pulse width of 200 μs and frequency of 10 Hz, with an intensity that can be modulated by the patient. Full technical characteristics are available online (https://www.tensiplus.com/en/content/20-tensiplus-medical-device) and are detailed in a previous publication [19]. A phone call was scheduled a few days after treatment initiation to check for any problems or malfunction of the device.

2.3. Evaluation criteria

Baseline evaluation included patient characteristics, medical history, associated conditions, a 3-d bladder diary (number of voids, number of urgency episodes, number of nocturia episodes, number of UUI episodes, and total voided volume per 24 h, and maximum functional bladder capacity), Urinary Symptom Profile (USP) questionnaire [20], and OAB-q [21,22] questionnaires for the Bother and Symptom domains. PVR was measured before inclusion using a Bladder-scan device. Quality of life (QoL) was evaluated using a Visual Analogue Scale (VAS) instrument, with scores ranging from 0 to 10.

The 3-mo evaluation included bladder diary data and USP, OABq, VAS-QoL, and Patient Global Impression of Improvement (PGI-I) questionnaires [23]. An ad hoc specific questionnaire was used to assess the patient experience (Supplementary material). Treatment observance was classified as perfect, minor deviation (no stimulation on ≤1 d/wk), major deviation (no stimulation on >1 d/wk), or interrupted (patient stopped treatment). At the 3-mo visit, patients reported any adverse events and were offered the option to continue treatment up to another visit at 6 mo, when the USP, VAS-QoL, and PGI-I questionnaires were completed again (Fig. 1). Patients were not allowed to start any other OAB treatment during the study period.

2.4. Outcome measures

The primary outcome was efficacy at 3 mo, according to objective improvements and patient satisfaction. A composite clinical response (CCR) was defined as (1) a decrease of at least 30% in urgency, frequency, and/or UUI episodes in comparison to baseline on 3-d bladder diary and (2) a PGI-I score of 1 or 2 (very much improved or much improved). Treatment success was defined as any improvement ≥30% for bladder diary parameters or a PGI-I score ≤3. Secondary outcomes were changes in other symptoms and urinary parameters, USP, OAB-q, and VAS scores, and treatment persistence. Tolerance was evaluated in terms of self-reporting of any adverse events. Data on satisfaction and consumer ratings for device usability were also collected.

2.5. Statistical analysis

On the basis of literature data on the efficacy of PTNS [24–26], our main hypothesis was a success rate of 50% for TENSI+ treatment. Using a wide confidence interval of 20% and taking into account a potential dropout rate of 10%, we estimated a sample size of 100 patients. Statistical analysis was performed with EasyMedStat v3.27. Results for quantitative variables are presented as the mean and standard deviation or the median and interquartile range (IQR), depending on the distribution. The distribution normality was checked using the Shapiro-Wilk test. Comparisons of scores and data between 3 mo and baseline were conducted using the Wilcoxon rank-sum test or the Student paired *t* test, depending on normality.

3. Results

3.1. Study population

The study flowchart is shown in Figure 2. Between May and November 2022, 79 patients were enrolled in seven centres. Of the 65 patients who attended their 3-mo visit, ten report treatment deviation (seven minor, three major) and one

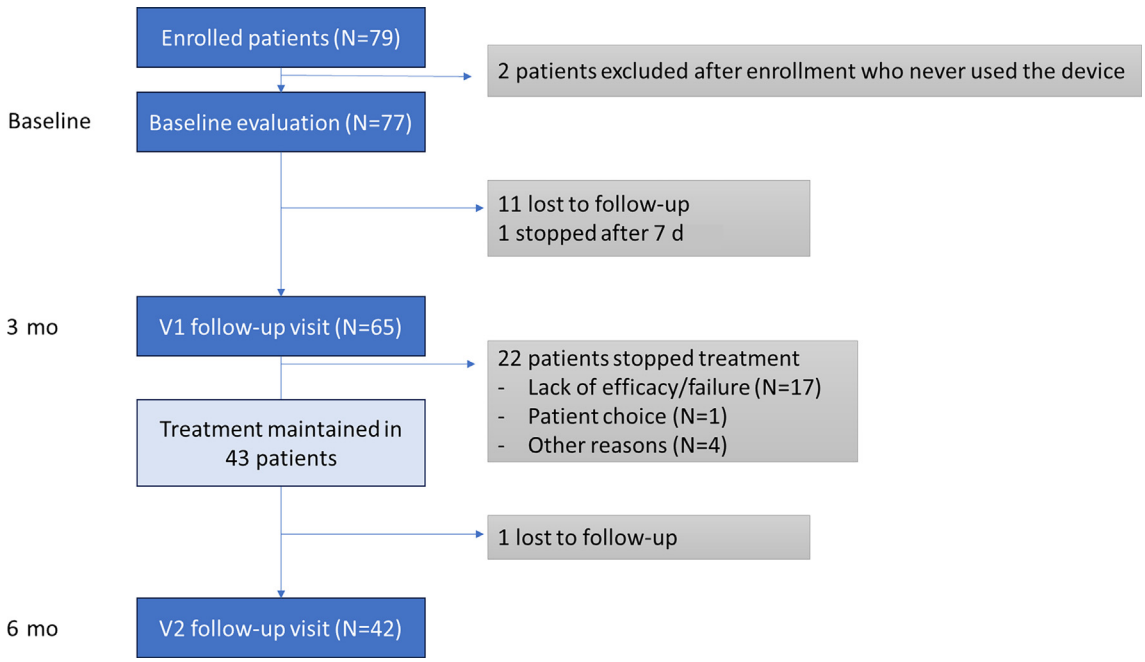

Fig. 2 – Study flowchart.

Table 1 – Patient characteristics at baseline (*n* = 77)

Parameter	Result
Median age, yr (IQR)	56.34 (43–68)
Sex, *n* (%)	
Male	13 (16.5)
Female	64 (83.5)
Median BMI, kg/m^2 (IQR)	25 (22–27)
Associated conditions, *n* (%)	
Neurological disease	9 (11.54)
Recurrent UTIs	7 (8.97)
Chronic pelvic pain >6 mo	5 (6.41)
Diabetes	2 (2.56)
Constipation	17 (21.79)
Previous anticholinergic use	21 (26.92)
Current medications, *n* (%)	
None	21 (27)
Anticoagulants	3 (4)
L-Thyroxin	1 (1)
α-Blocker	1 (1)
Laxatives	5 (6)
Statins	3 (4)
Anxiolytics	6 (8)
Antidepressants	2 (3)
Missing information	38 (48)
Female-specific data, *n* (%)	
Menopause	34 (51)
Hormonal treatment	5 (7)
Local oestrogen	1 (1)
Oestriol	1 (1)
Pelvic organ prolapse	6 (9)
Male-specific data, *n* (%)	
Male LUTS/BPH diagnosis	6 (46)
Median prostate size, (IQR)	31 (18–44)
History of prostate cancer	2 (15)

BMI = body mass index; BPH = benign prostatic hyperplasia; IQR = interquartile range; LUTS = lower urinary tract symptoms; UTI = urinary tract infection.

stopped treatment after 1 wk. Of the 43 patients who continued after 3 mo, one patient had major deviations and two stopped treatment.

3.2. Baseline characteristics

Patient characteristics are listed in Table 1. In addition to OAB (defined as the presence of urgency), 15 patients had stress incontinence, nine had UUI, and 32 had mixed urinary incontinence. All patients reported impaired QoL and a high level of bother at baseline (Table 2).

3.3. Efficacy

Of the 65 patients evaluated at 3 mo, 25 (38%) had a CCR, 19 (29%) reported an improvement in bladder diary parameters and/or PGI score, 12 were unchanged, and four reported worsening of their condition (Fig. 3). To take into account dropouts, a plot of best and worst case scenarios is shown in Figure 3, considering that all dropouts could be classified as a success (best case), improvement, unclear/unchanged, or worse (worst case). The median PGI-I score was 2.0 (IQR 1.0), indicating a high level of satisfaction overall. A per-protocol analysis of bladder diary data (available for 59 patients) revealed that symptoms in 41/59 patients reflected a positive treatment response, with a decrease of at least 30% for at least one of the parameters measured (frequency and/or urgency episodes and/or UUI episodes). Among patients with UUI at baseline, seven of 40 experienced complete resolution of their symptoms, with 13 reporting an improvement of >50%. The data in Table 2 show that urgency, frequency, nocturia, and UUI episodes all significantly decreased under treatment. However, maximum functional bladder capacity and total voided volume per 24 h did not change significantly. The USP-OAB subscore and the OAB-q Bother and OAB-q Symptom scores significantly decreased (Table 2). QoL also significantly improved, and 79% of the patients would recommend the treatment to a friend. The specific patient experience questionnaire, comprising multiple choice questions, confirmed the ease of use, clarity, and very high satisfaction. The device was judged to be easy to set up and use, intuitive, user-friendly, and portable, allowing movement and with a long-lasting power battery. Detailed answers to the patient questionnaire are provided in the Supplementary material.

Forty-seven patients continued treatment up to 6 mo; 42 patients were available for data analysis at this time point, as five patients discontinued treatment. Only questionnaire completion was required at 6 mo. The results confirm sustained efficacy of the treatment, with symptom, QoL, and satisfaction scores comparable to the 3-mo data (Fig. 3). PGI-I results revealed that patient satisfaction was maintained, with scores of 1, 2, and 3 reported by 12, 17, and

Table 2 – Symptoms at baseline and follow-up

Parameter [a]	Baseline	3 mo	*p* value	6 mo
Bladder diary				
Number of voids (*n*/24 h)	10.0 (4.0)	8.00 (3.0)	<0.001	–
Number of urgency episodes (*n*/24 h)	4.0 (3.0)	2.00 (3.0)	<0.001	–
Number of nocturia episodes (*n*/24 h)	2.0 (1.0)	1.00 (1.0)	<0.001	–
Maximum voided volume (ml)	390.0 (200.0)	400.0 (200.0)	0.98	–
Number of UUI episodes (*n*/24 h)	1.0 (2.0)	0.00 (0.0)	<0.001	–
Total voided volume (ml/24 h)	1600 (993)	1600 (790)	0.763	–
USP scores				
Stress incontinence (out of 9)	1.0 (5.0)	1.00 (3.0)	0.084	0.0 (3.25)
Overactive bladder (out of 21)	10.0 (4.0)	7.00 (6.0)	0.001	6.0 (4.0)
Voiding difficulties (out of 9)	1.0 (2.0)	0.00 (2.0)	0.349	0.0 (2.0)
OABq-Bother score	22.0 (12.0)	15.0 (8.25)	0.001	15.0 (8.5)
OABq-Symptoms score	39.5 (21.25)	30.0 (19.5)	0.001	28.0 (18.0)
VAS quality of life score	4.5 (1.75)	7.00 (3.0)	0.001	7.0 (2.0)

OABq = Overactive Bladder questionnaire; USP = Urinary Symptom Profile; UUI = urge urinary incontinence; VAS = Visual Analogue Scale.
[a] All results are presented as median (interquartile range).

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	PGI-I	Symptoms	*n* (%)
Complete clinical response	**1–2**	>30% change	25 (38%)
Improvement	**1–2**	<30% change	6 (9%) *
	3	>30% change	10 (15%)
	3	<30% change	3 (4%)
Unclear	**4**	>30% change	5 (8%)
No change	**4**	<30% change	12 (20%) *
Worsened	**5 or less**	>30% change	1 (2%)
	5 or less	<30% change	3 (4%)

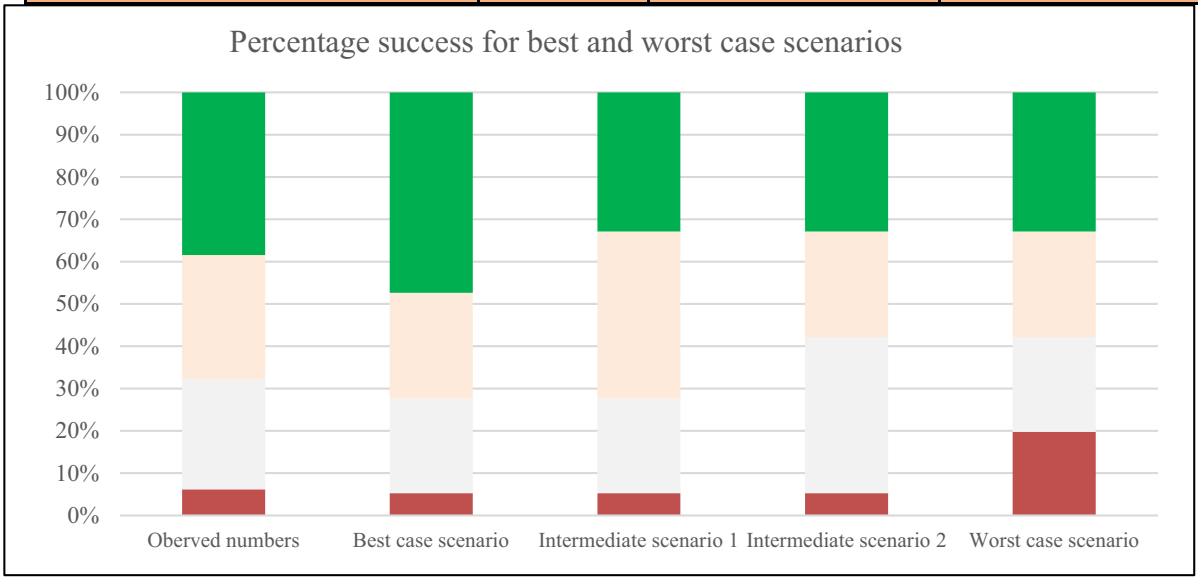

Fig. 3 – Clinical success according to bladder diary and Patient Global Impression of Improvement (PGI-I) data. * Three missing bladder diaries. Best and worst case scenarios are plotted, with allocation of the 11 patients lost to follow-up to success (best case), improvement, unclear/no change, or worsened (worst case).

nine patients, respectively. Four patients reported a PGI-I score of 4. Of these four patients, three had experienced no change at 3 mo but wanted to persevere with treatment, and one had a previous positive response but stopped treatment for personal reasons.

3.4. Safety outcomes

Only two patients reported adverse events, which were minor and spontaneously resolved after stopping use of the device. One patient report transient pelvic discomfort and the other felt electric shocks but continued the treatment. No adverse events leading to treatment discontinuation occurred.

4. Discussion

Our prospective clinical trial clearly established the efficacy of TENSI+ in multiple dimensions, including objective and subjective evaluation of symptoms, bother, QoL, satisfaction, and user experience, according to data collected using validated instruments. An excellent safety profile was also observed. These results confirm the relevance of TENSI+ therapy for management of OAB symptoms, although formal head-to-head comparisons with other TTNS devices and/or medications are needed to definitively establish indications for TENSI+ treatment in the OAB management armamentarium.

In contrast to previous reports, we prespecified a stringent composite primary outcome that combines an objective improvement (>30%) in symptoms on the bladder diary and patient satisfaction according to a PGI-I score of 1 or 2. CCR was achieved in 38% of the patients, and an additional 29% experienced improvements, leading to a success rate of 67% (Fig. 3). However, in some cases an improvement in PGI-I score was observed without symptom variation on the bladder diary, which can be due to a placebo effect. Con-

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versely, in five cases, symptoms objectively improved but the situation was considered as "unchanged" by the patient on PGI-I. Owing to the small numbers, no clear interpretation of these discrepancies was possible. Our decision in these cases was to propose therapy maintenance and judge the definitive results at 6 mo. All patients chose to continue treatment after 3 mo, with only five cases of treatment interruption at the second visit.

The literature on TTNS has shown variability in the treatment persistence rate, depending on the study design, the device used, and follow-up duration [14–17]. The high persistence rate we observed can be attributed to the short 6-mo follow-up, since most treatment interruptions occur in the medium term for TTNS. Te Dorsthorst et al [26] observed median persistence of 16 mo, while Leroux et al [27] reported mean persistence of 8.3 mo. Owing to the short follow-up in the current study, mid- and long-term discontinuation rates for the TENSI+ device remain unknown. However, beyond its efficacy, the user-friendly design can be considered as a significant asset for treatment maintenance. In our study cohort, 88% of patient rated their experience with the device as positive, including its use, adaptability, and reliability; technical difficulties and constraints have been identified as potential drivers of treatment interruption [26]. The ease of use, portability, and reliability of the device are thus essential and could improve the patient experience and potentially increase the persistence rate. Recent studies have shown that home-based TTNS therapy is associated with a positive experience in comparison to treatment administration in a health care centre, and a willingness to continue in the longer term, highlighting the importance of patient perception and motivation [28]. However, it is important to note that our ad hoc supplementary questionnaire (Supplementary material) was specifically oriented to evaluate some specific features of the device and may include some biases to positive responses. The potential lack of objectivity and calibration of this questionnaire means that it should be considered as complementary qualitative information rather than part of the study data set.

Some parameters did not significantly improve under treatment. First, total voided volume per 24 h did not change. This result proves that patients did not modify their drinking habits and fluid intake, which is important because any change can bias the results, notably for frequency, which is often under-reported in OAB research. Maximum bladder capacity was also unchanged. Although an increase in this parameter could have been expected, several reasons can explain its stability. First, the magnitude of the TTNS effect is rather low, with a median difference in the daily number of voids of two, which is significant but not enough to modify bladder capacity per se. Second, the baseline bladder capacity was ~400 ml, which is already close to normal and unlikely to change. Third, the TTNS effect was more obvious for sensory symptoms (eg, urgency) [29], and TTNS is probably less likely to modify bladder capacity, compliance, or other histopathological characteristics of the bladder wall. Furthermore, a recent investigation revealed poor correlation between maximum bladder capacity and global results for bladder diary parameters [30].

USP questionnaire responses revealed that a number of patients had some stress incontinence and/or voiding difficulties at baseline. During the treatment phase, none of these symptoms improved significantly. This is in line with literature data indicating that the effects of PTNS on non-obstructive urinary retention are somewhat unclear and limited [31]. As a counterpoint, it is possible that these associated symptoms may have hampered the efficacy of the therapy, and the relatively high response rate may be considered as quite favourable in that regard. Whether the response rate could be higher in more "genuine" OAB populations should be explored in further investigations.

Our univariate analysis did not identify any factors predictive of success. We tested the association with BMI, age, or sex (Mann-Whitney *U* test), neurological background or previous use of anticholinergics (χ^2 test), or efficacy, without finding any significant results. Beyond the possible lack of power inherent to the limited number of patients included, these results are not surprising, as patient selection for second- and third-line options remains difficult [32]. Although neurogenic OAB and non-neurogenic OAB are considered to be distinct conditions in clinical practice, the efficacy seems similar for both according to the literature [33]; in any case, there is no reason not to try TTNS given its noninvasive profile. Several different pathways and underlying mechanisms have been postulated for non-neurogenic OAB [6], but patient selection remains based on tolerance issues, clinical profiles, and patient preferences [34]. Future studies may help to identify factors predicting treatment success, especially if machine learning or artificial intelligence is applied [34].

Our study has several strengths, including a prospective design and comprehensive and multidimensional clinical evaluation during follow-up. The absence of strict exclusion criteria meant that we could include a variety of clinical profiles, which increases the generalisability of the results. The homogeneous patient education via an at-home visit from a specialised nurse avoided any bias or patient misuse. However, some limitations must be acknowledged. First, while the sample size calculation was based on an efficacy likelihood of approximately 66%, we targeted inclusion of approximately 100 patients. Although we almost reached this number, 11 patients dropped out of the study in the initial treatment phase because of a missing bladder diary, reducing the exploitable complete data set to 65 patients (instead of ~90 patients after accounting for a 10% dropout rate). However, while this lower power may dramatically impact some analyses (such as predictive factors), we consider that the study is still fully relevant as an evaluation of the validity of our therapeutic approach. Data for other new devices have been presented for very small cohorts of approximately ten patients [35,36], in addition to studies evaluating detailed experience with the use of transcutaneous devices [28]. As the current study is mostly descriptive, the decision was made to present results for patients who had data available, which may be considered as a per-protocol analysis rather than an intent-to-treat analysis. The brief recruitment period was determined by the sponsor, who ultimately halted the inclusion period. Apart

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from delays in opening centres, no clear systematic limitations for inclusion were identified.

Limited follow-up duration is another drawback, as OAB therapy persistence decreases over time [37]. Long-term follow-up via clinical registries would be of utmost interest for better evaluation of the persistence rate for the therapy and underlying causes.

As the study design involved offering TTNS as a first-line therapeutic option, urodynamics data were not available for all patients. This is because urodynamics are not required in "virgin" OAB cases, notably in a non-neurogenic context. Treatment of symptoms prevails in this situation, after appropriate clinical work-up, and the risk-benefit balance of urodynamics has not been evaluated. Other limitations include the lack of evaluation of sexual symptoms and bowel symptoms. Although some studies have proposed that PTNS may play a role in management of sexual and faecal disorders [38], these items were considered beyond the scope of the initial phase of the study. Further clinical studies should evaluate the impact of TENSI+ use on these symptoms.

5. Conclusions

In this short-term prospective clinical trial, TENSI+ was effective for OAB management in both sexes, with an excellent safety profile. Further studies are needed to confirm these preliminary data.

Author contributions: Jean-Nicolas Cornu had full access to all the data in the study and takes responsibility for the integrity of the data and the accuracy of the data analysis.

Study concept and design: Cornu, Peyronnet, Mariadassou.
Acquisition of data: Cornu, Donon, Thullier, Meyer, Klap, Campagne-Loiseau, Peyronnet.
Analysis and interpretation of data: Cornu, Mariadassou.
Drafting of the manuscript: Cornu.
Critical revision of the manuscript for important intellectual content: Donon, Thullier, Meyer, Klap, Campagne-Loiseau, Peyronnet.
Statistical analysis: Cornu.
Obtaining funding: Cornu, Mariadassou.
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Supervision: Cornu, Peyronnet.
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Appendix A. Supplementary material

Supplementary data to this article can be found online at https://doi.org/10.1016/j.euf.2024.05.013.

References

[1] Abrams P, Cardozo L, Fall M, et al. The standardisation of terminology in lower urinary tract function: report from the standardisation sub-committee of the International Continence Society. Urology 2003;61:37–49.
[2] Haylen BT, de Ridder D, Freeman RM, et al. An International Urogynecological Association (IUGA)/International Continence Society (ICS) joint report on the terminology for female pelvic floor dysfunction. Neurourol Urodyn 2010;29:4–20.
[3] Drake MJ. Do we need a new definition of the overactive bladder syndrome? ICI-RS 2013. Neurourol Urodyn 2014;33:622–4.
[4] Cornu JN, Amarenco G, Bruyere F, et al. Prevalence and initial management of overactive bladder in France: a cross-sectional study. Prog Urol 2016;26:415–24.
[5] Hartmann KE, McPheeters ML, Biller DH, et al. Treatment of overactive bladder in women. Evidence Report/Technology Assessment no. 187. Rockville, MD: Agency for Healthcare Research and Quality; 2009.
[6] Peyronnet B, Mironska E, Chapple C, et al. A comprehensive review of overactive bladder pathophysiology: on the way to tailored treatment. Eur Urol 2019;75:988–1000.
[7] Nambiar AK, Arlandis S, Bø K, et al. European Association of Urology guidelines on the diagnosis and management of female non-neurogenic lower urinary tract symptoms. Part 1: diagnostics, overactive bladder, stress urinary incontinence, and mixed urinary incontinence. Eur Urol 2022;82:49–59.
[8] Wang M, Jian Z, Ma Y, Jin X, Li H, Wang K. Percutaneous tibial nerve stimulation for overactive bladder syndrome: a systematic review and meta-analysis. Int Urogynecol J 2020;31:2457–71.
[9] Schneider MP, Gross T, Bachmann LM, et al. Tibial nerve stimulation for treating neurogenic lower urinary tract dysfunction: a systematic review. Eur Urol 2015;68:859–67.
[10] Booth J, Connelly L, Dickson S, Duncan F, Lawrence M. The effectiveness of transcutaneous tibial nerve stimulation (TTNS) for adults with overactive bladder syndrome: a systematic review. Neurourol Urodyn 2018;37:528–41.
[11] Finazzi-Agrò E, Petta F, Sciobica F, Pasqualetti P, Musco S, Bove P. Percutaneous tibial nerve stimulation effects on detrusor overactivity incontinence are not due to a placebo effect: a randomized, double-blind, placebo controlled trial. J Urol 2010;184:2001–6.
[12] Peters KM, Carrico DJ, Perez-Marrero RA, et al. Randomized trial of percutaneous tibial nerve stimulation versus sham efficacy in the treatment of overactive bladder syndrome: results from the SUmiT trial. J Urol 2010;183:1438–43.
[13] Preyer O, Umek W, Laml T, et al. Percutaneous tibial nerve stimulation versus tolterodine for overactive bladder in women: a randomised controlled trial. Eur J Obstet Gynecol Reprod Biol 2015;191:51–6.
[14] Alomari MS, Abdulhamid AS, Ghaddaf AA, et al. Non-inferior and more feasible transcutaneous tibial nerve stimulation in treating overactive bladder: a systematic review and meta-analysis. Int J Urol 2022;29:1170–80.
[15] Martin-Garcia M, Crampton J. A single-blind, randomized controlled trial to evaluate the effectiveness of transcutaneous tibial nerve stimulation (TTNS) in overactive bladder symptoms in women responders to percutaneous tibial nerve stimulation (PTNS). Physiotherapy 2019;105:469–75.
[16] Ramírez-García I, Blanco-Ratto L, Kauffmann S, et al. Efficacy of transcutaneous stimulation of the posterior tibial nerve compared to percutaneous stimulation in idiopathic overactive bladder syndrome: randomized control trial. Neurourol Urodyn 2019;38:261–8.
[17] Yang DY, Zhao LN, Qiu MX. Treatment for overactive bladder: a meta-analysis of transcutaneous tibial nerve stimulation versus percutaneous tibial nerve stimulation. Medicine 2021;100:e25941.
[18] Cornu JN, Klap J, Thuillier C, et al. Efficacy and safety of the TENSI+ device for posterior tibial nerve stimulation: a multicenter, retrospective study. Prog Urol 2023;33:541–6.

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[19] Cornu JN, Haishim H, Van der Aa F, et al. How I do it: transcutaneous tibial nerve stimulation TENSI+ system. Can J Urol 2023;30:11756–61.
[20] Haab F, Richard F, Amarenco G, et al. Comprehensive evaluation of bladder and urethral dysfunction symptoms: development and psychometric validation of the Urinary Symptom Profile (USP) questionnaire. Urology 2008;71:646–56.
[21] McKown S, Abraham L, Coyne K, Gawlicki M, Piault E, Vats V. Linguistic validation of the N-QOL (ICIQ), OAB-q (ICIQ), PPBC, OAB-S and ICIQ-MLUTSsex questionnaires in 16 languages. Int J Clin Pract 2010;64:1643–52.
[22] Yalcin I, Patrick DL, Summers K, Kinchen K, Bump RC. Minimal clinically important differences in Incontinence Quality-of-Life scores in stress urinary incontinence. Urology 2006;67:1304–8.
[23] Arrabal-Polo MA, Palao-Yago F, Campon-Pacheco I, Martinez-Sanchez M, Zuluaga-Gomez A, Arrabal-Martin M. Clinical efficacy in the treatment of overactive bladder refractory to anticholinergics by posterior tibial nerve stimulation. Korean J Urol 2012;53:483–6.
[24] Tellenbach M, Schneider M, Mordasini L, Thalmann GN, Kessler TM. Transcutaneous electrical nerve stimulation: an effective treatment for refractory non-neurogenic overactive bladder syndrome? World J Urol 2013;31:1205–10.
[25] Tutolo M, Ammirati E, Heesakkers J, et al. Efficacy and safety of sacral and percutaneous tibial neuromodulation in non-neurogenic lower urinary tract dysfunction and chronic pelvic pain: a systematic review of the literature. Eur Urol 2018;73:406–18.
[26] Te Dorsthorst M, van Balken M, Janssen D, Heesakkers J, Martens F. Real-life patient experiences of TTNS in the treatment of overactive bladder syndrome. Ther Adv Urol 2021;13:17562872211041470.
[27] Leroux PA, Brassart E, Lebdai S, Azzouzi AR, Bigot P, Carrouget J. Transcutaneous tibial nerve stimulation: 2 years follow-up outcomes in the management of anticholinergic refractory overactive bladder. World J Urol 2018;36:1455–60.
[28] Daly CME, Loi L, Booth J, Saidan D, Guerrero K, Tyagi V. Self-management of overactive bladder at home using transcutaneous tibial nerve stimulation: a qualitative study of women's experiences. BMC Women's Health 2021;21:374.
[29] Kulawik J, Cornu JN. Re: Real-time changes in brain activity during tibial nerve stimulation for overactive bladder: evidence from functional near-infrared spectroscopy hype scanning. Eur Urol 2023;84:598.
[30] López-Fando Lavalle L, Calleja Hermosa P, Velasco Balanza C, et al. Bladder capacity in women with overactive bladder syndrome: a cross-sectional study. Urology 2023;179:44–9.
[31] Ho FCS, He C, Yao HH, O'Connell HE, Gani J. Efficacy of sacral neuromodulation and percutaneous tibial nerve stimulation in the treatment of chronic nonobstructive urinary retention: a systematic review. Neurourol Urodyn 2021;40:1078–88.
[32] Zillioux J, Slopnick EA, Vasavada SP. Third-line therapy for overactive bladder in the elderly: nuances and considerations. Neurourol Urodyn 2022;41:1967–74.
[33] Wang CN, Chung DE. Neuromodulation for lower urinary tract symptoms in special populations. Neurourol Urodyn 2022;41:1948–57.
[34] Kapur A, Harandi AA, Cohen T, et al. An analysis of factors that influence patient preference of third-line therapy for overactive bladder. Neurourol Urodyn 2022;41:1906–13.
[35] Sirls LT, Schonhoff A, Waldvogel A, Peters KM. Development of an implant technique and early experience using a novel implantable pulse generator with a quadripolar electrode array at the tibial nerve for refractory overactive bladder. Neurourol Urodyn 2023;42:427–35.
[36] Burton CS, Sokol ER. Pilot study of a novel at-home posterior tibial nerve system for overactive bladder syndrome. Urogynecology 2024;30:107–13. https://doi.org/10.1097/SPV.0000000000001399.
[37] Dmochowski RR, Newman DK, Rovner ES, Zillioux J, Malik RD, Ackerman AL. Patient and clinician challenges with anticholinergic step therapy in the treatment of overactive bladder: a narrative review. Adv Ther 2023;40:4741–57.
[38] Tahmasbi F, Mosaddeghi-Heris R, Soleimanzadeh F, et al. Effects of posterior tibial nerve stimulation on fecal incontinence: an umbrella review. Neuromodulation 2024;27:229–42.

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tensi+

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Tensi+. Transcutaneous electrical nerve stimulation (TENS) of the posterior tibial nerve. Indication: treatment of idiopathic or neurological overactive bladder. DM class IIa. CE 2797 : BSI. Read package leaflet carefully. 04/06/2024