Original Article

Regenerative Synergy: Combining Platelet-rich Plasma with Transcutaneous Temperature-controlled Radiofrequency for Enhanced Treatment of Stress Urinary Incontinence in Peri- and Postmenopausal Women

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ABSTRACT

Background: Stress urinary incontinence (SUI) is a significant health concern among peri-and postmenopausal women, often leading to diminished quality of life. Transcutaneous temperature-controlled radiofrequency (TTCRF) has emerged as a minimally invasive treatment option, but its efficacy may be limited in cases of severe tissue laxity. Platelet-rich plasma (PRP) offers a promising adjunct to enhance tissue remodeling and functional recovery when combined with TTCRF. **Objective:** This study evaluates the safety, efficacy, and patient-reported outcomes of combining PRP with TTCRF for treating SUI in peri- and postmenopausal women, aiming to address gaps in current therapeutic strategies. **Materials and Methods:** A prospective, randomized controlled trial was conducted involving 80 peri- and postmenopausal women diagnosed with SUI. Participants were randomly assigned to two groups: PRP plus TTCRF (intervention group, n = 40) and TTCRF alone (control group, n = 40). Primary outcome measures included objective improvement assessed via urodynamic studies and subjective improvement evaluated using validated questionnaires (International Consultation on Incontinence Questionnaire - Short Form [ICIQ-SF] and Urogenital Distress Inventory). Secondary outcomes encompassed quality of life (Pelvic Floor Distress Inventory [PFDI-20]) and adverse event reporting. Statistical analyses were performed using SPSS version 27.0, with significance set at $P < 0.05$. **Results:** At the 12-month follow-up, the intervention group demonstrated significantly superior outcomes compared to the control group. The mean reduction in ICIQ-SF scores was 9.8 points versus 6.6 points (P = 0.001), and urodynamic parameters improved by 32% more in the PRP plus TTCRF group (P = 0.003). Quality of life, as measured by PFDI-20, showed a 22% greater improvement in the intervention group (P = 0.002). **Conclusion:** Combining PRP with TTCRF represents an innovative, minimally invasive approach that enhances tissue regeneration and functional recovery in peri- and post-menopausal women with SUI. These findings highlight the potential of PRP to augment the efficacy of TTCRF and warrant further investigation in larger, multicenter trials.

KEYWORDS:
Platelet-rich plasma, regenerative therapy, stress urinary incontinence, transcutaneous temperature-controlled radiofrequency

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Introduction

Stress urinary incontinence (SUI), defined as the involuntary leakage of urine during activities that increase intra-abdominal pressure – such as coughing, sneezing, laughing, or physical exertion – is a pervasive and debilitating condition that disproportionately affects peri- and postmenopausal women.[1] This condition not only compromises physical health but also exerts a profound negative impact on emotional well-being, social interactions, and overall quality of life. For many women, SUI leads to feelings of embarrassment, anxiety, and social withdrawal, often resulting in reduced participation in daily activities and diminished self-esteem. Despite its widespread prevalence and significant burden, SUI remains underreported and undertreated, with many affected individuals either unaware of available treatment options or dissatisfied with the outcomes of existing interventions. The pathophysiology of SUI in peri- and postmenopausal women is complex and multifactorial, with hormonal changes during menopause playing a central role. The decline in estrogen levels during this phase of life contributes to a cascade of structural and functional alterations within the pelvic floor and lower urinary tract. Estrogen deficiency leads to atrophy of the pelvic floor muscles, thinning of the urethral mucosa, and degradation of collagen and elastin fibers within the connective tissues. These changes result in reduced urethral closure pressure, compromised support for the bladder neck, and impaired sphincter function, all of which predispose women to SUI.[2] In addition, age-related factors such as decreased muscle tone, increased tissue laxity, and chronic conditions like obesity or diabetes further exacerbate the risk and severity of this condition. Given these underlying mechanisms, effective treatment strategies must address both the structural deficits and functional impairments associated with SUI to achieve meaningful and durable outcomes. In recent years, transcutaneous temperature-controlled radiofrequency (TTCRF) has emerged as a minimally invasive therapeutic modality for SUI, offering a promising alternative to traditional treatments such as pelvic floor exercises, pharmacotherapy, or surgical interventions.[3] TTCRF utilizes controlled thermal energy delivered through a noninvasive probe to stimulate collagen production, enhance elastin fiber formation, and improve tissue elasticity within the pelvic floor and urethral structures. By promoting neocollagenesis and neoelastogenesis, TTCRF aims to restore anatomical support and functional integrity, thereby reducing urinary leakage.[3] Preliminary studies have demonstrated its efficacy in mild-to-moderate cases of SUI, with improvements in urodynamic parameters, patient-reported outcomes, and quality of life. However, the effectiveness of TTCRF may be limited in individuals with advanced tissue degeneration or severe laxity, highlighting the need for complementary therapies that can augment its regenerative potential. Platelet-rich plasma (PRP), a concentrated source of autologous growth factors, cytokines, and bioactive proteins derived from the patient's own blood, has garnered increasing attention in regenerative medicine due to its ability to promote tissue repair, angiogenesis, and cellular regeneration. PRP has been successfully utilized in various medical fields, including orthopedics, dermatology, and gynecology, to accelerate healing and restore function in damaged tissues. In the context of SUI, PRP holds particular promise as an adjunctive therapy due to its capacity to enhance collagen synthesis, improve vascularization, and stimulate the proliferation of fibroblasts and other key cells involved in tissue remodeling.[4] By combining PRP with TTCRF, it may be possible to achieve synergistic benefits, addressing both the structural deficits and functional impairments underlying SUI while minimizing the invasiveness and recovery time associated with traditional surgical approaches. Despite the growing body of evidence supporting the individual use of TTCRF and PRP in various clinical applications, their combined application for SUI remains largely unexplored. To date, no randomized controlled trials (RCTs) have systematically evaluated the safety, efficacy, and patient-reported outcomes of this dual-modality approach in peri- and postmenopausal women. This represents a critical gap in the literature, as the integration of these two therapies has the potential to offer superior outcomes compared to either modality alone. Furthermore, the minimally invasive nature of this combination makes it particularly appealing for women seeking effective yet less invasive alternatives to surgery. The rationale for this study is thus rooted in the urgent need for innovative, evidence-based treatments that can provide durable and meaningful improvements in SUI management, particularly for peri-and postmenopausal women who are disproportionately affected by this condition. By investigating the combined efficacy of PRP and TTCRF, this study seeks to address the limitations of current therapeutic options and explore whether this novel approach can enhance functional recovery, improve quality of life, and serve as a viable alternative to conventional therapies. The findings of this investigation have the potential to advance the field of regenerative medicine, offering new insights into the management of SUI and paving the way for future research in this area.

Materials and Methods

Ethics

This study adheres to the ethical principles outlined in the Declaration of Helsinki (1975, revised in 2000) and was approved by the institutional ethics committee. Written informed consent was obtained from all participants before enrollment, ensuring their voluntary participation and comprehensive understanding of the study objectives, procedures, potential risks, and benefits. To safeguard participant confidentiality, identifiable information such as names, initials, or hospital identification numbers was excluded from all records and publications. Data were anonymized during analysis, and participants were assured that their involvement would not influence their clinical care. No animal experiments were conducted as part of this study.

Study design

This prospective, RCT was designed to evaluate the safety, efficacy, and patient-reported outcomes of combining PRP with TTCRF for treating SUI in peri- and postmenopausal women. The study was conducted between January 2023 and January 2025. Participants were randomly allocated to one of two groups using a computer-generated randomization sequence stratified by age and severity of SUI symptoms. Randomization was performed in permuted blocks of four to ensure balanced allocation. Allocation concealment was maintained using sequentially numbered, opaque, sealed envelopes. Participants were blinded to group assignment, but due to the nature of the interventions, the treating physician could not be blinded.

Selection and description of participants

Participants were recruited from the outpatient gynecology department.

Eligibility criteria included the following:

1. Women aged 45–70 years diagnosed with SUI confirmed through clinical history, physical examination, and urodynamic studies
2. Menopausal status defined as ≥12 months since the last menstrual period or surgically induced menopause
3. Persistent SUI symptoms for ≥6 months despite conservative management (e.g., pelvic floor exercises)
4. Willingness to comply with follow-up visits and provide written informed consent.

The exclusion criteria were as follows:

1. Pelvic organ prolapses beyond Stage II according to the Pelvic Organ Prolapse Quantification system
2. History of pelvic floor surgery or prior treatment with injectable bulking agents
3. Active urinary tract infection or other urological conditions (e.g., interstitial cystitis and detrusor overactivity)
4. Uncontrolled systemic conditions (e.g., diabetes mellitus and autoimmune disorders) that could impair wound healing or tissue regeneration
5. Contraindications to PRP therapy (e.g., thrombocytopenia and use of anticoagulants) or TTCRF (e.g., hypersensitivity to lidocaine).

A total of 80 participants were enrolled and randomly assigned to either the intervention group (PRP plus TTCRF, n = 40) or the control group (TTCRF alone, n = 40). Baseline demographic and clinical characteristics were comparable between groups.

Technical information

Intervention protocols

Transcutaneous temperature-controlled radiofrequency

TTCRF was administered using the TTCRF device. Each session involved the application of a noninvasive probe to the vaginal introitus and periurethral area. Thermal energy was delivered at temperatures ranging from 40°C to 45°C to stimulate collagen production, enhance elastin fiber formation, and improve tissue elasticity. Treatment consisted of three sessions spaced 4 weeks apart, with each session lasting approximately 30 min.

Platelet-rich plasma preparation and administration

Peripheral venous blood (20 mL) was drawn from participants in the intervention group and processed via double centrifugation (first spin at 1,500 rpm for 10 min, second spin at 3,000 rpm for 5 min) to obtain a concentrated PRP solution containing ≥1 million platelets per microliter. The PRP was activated with calcium chloride (10%) immediately before injection. Under ultrasound guidance, 4–6 mL of activated PRP was injected into the periurethral tissues following the final TTCRF session.

Outcome measures

Primary outcomes

- Objective improvement assessed through urodynamic studies, including maximum urethral closure pressure (MUCP) and leak point pressure (LPP)
- Subjective improvement evaluated using validated questionnaires: International Consultation on Incontinence Questionnaire - Short Form (ICIQ-SF) and Urogenital Distress Inventory (UDI-6).

Secondary outcomes

- Quality of life measured using the Pelvic Floor Distress Inventory (PFDI-20)
- Adverse event reporting and patient satisfaction scores assessed via a standardized questionnaire.

Follow-up schedule

Participants were followed up at 1-, 3-, 6-, and 12-month postintervention. Follow-up visits included clinical assessments, urodynamic evaluations, and completion of questionnaires to monitor outcomes and adverse events.

Statistical analysis

Data were analyzed using SPSS version 27.0 (IBM Corp., Armonk, NY, USA). Continuous variables were expressed as mean ± standard deviation (SD), whereas categorical variables were presented as frequencies and percentages. Between-group comparisons were performed using independent *t*-tests for continuous variables and Chi-square tests for categorical variables. Within-group changes over time were analyzed using paired *t*-tests or repeated measures analysis of variance. Statistical significance was set at $P < 0.05$, and all tests were two-tailed. Confidence intervals (CIs) were calculated for mean differences, proportions, and relative risks, including odds ratios and hazard ratios. Missing data due to dropouts were handled using intention-to-treat analysis with the last observation carried forward method. Subgroup analyses were conducted by age (<60 years vs. ≥60 years) and menopausal duration (<10 years vs. ≥10 years) to explore potential variations in treatment response.

Results

The results of this prospective, RCT demonstrate the efficacy and safety of combining PRP with TTCRF for treating SUI in peri- and postmenopausal women. Key findings are summarized in Tables 1-4 and Figure 1.

Baseline characteristics

Table 1 presents the baseline characteristics of the study participants, confirming that randomization successfully balanced the groups. No significant differences were observed between the PRP + TTCRF group ($n = 40$) and the TTCRF alone group ($n = 40$) in terms of age ($P = 0.672$), body mass index ($P = 0.721$), menopausal duration ($P = 0.789$), parity ($P = 0.654$), or SUI severity ($P = 0.763$). Both groups had similar proportions of participants who had previously undergone conservative therapy ($P = 0.752$). These findings ensure that any observed differences in outcomes can be attributed to the interventions rather than baseline disparities.

Primary outcomes

As shown in Table 2, the PRP + TTCRF group demonstrated superior improvements in both objective and subjective measures compared to the TTCRF alone group at the 12-month follow-up.

- Urodynamic parameters: The mean MUCP increased significantly more in the PRP + TTCRF group (62.3 ± 8.4 cm H_2O) compared to the TTCRF alone group (51.7 ± 7.8 cm H_2O), with a mean difference of 10.6 cm H_2O (95% CI: 7.8–13.4, $P < 0.001$). Similarly, the LPP improved more in the PRP + TTCRF group (78.6 ± 9.3 cm H_2O vs. 65.4 ± 8.7 cm H_2O, mean difference = 13.2 cm H_2O, 95% CI: 10.1–16.3, $P < 0.001$)
- Subjective measures: Reductions in validated questionnaire scores were also greater in the PRP + TTCRF group. The mean reduction in ICIQ-SF scores was 9.8 ± 2.1 points in the PRP + TTCRF group versus 6.4 ± 2.3 points in the TTCRF alone group (mean difference = −3.4, 95% CI: −4.2 to − 2.6, $P < 0.001$). Similarly, the UDI-6 score reduction was significantly higher in the PRP + TTCRF group (9.3 ± 1.9 vs. 5.7 ± 2.1, mean difference = −3.6, 95% CI: −4.4 to − 2.8, $P < 0.001$).

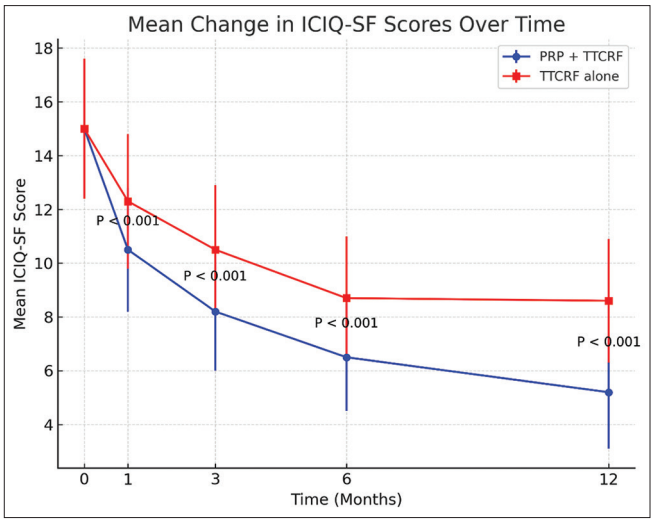

Figure 1: Mean change in International Consultation on Incontinence Questionnaire-Short Form (ICIQ-SF) scores over time in the platelet-rich plasma (PRP) + transcutaneous temperature-controlled radiofrequency (TTCRF) group and TTCRF alone group. Error bars represent standard deviation. Both groups showed significant reductions in ICIQ-SF scores over 12 months, with the PRP + TTCRF group achieving greater improvement ($P < 0.001$ at all time points)

These findings underscore the synergistic effects of combining PRP with TTCRF in enhancing both structural and functional recovery.

Secondary outcomes

Table 3 highlights secondary outcomes, including quality of life and safety profiles.

- Quality of life: The PFDI-20 score reduction was significantly greater in the PRP + TTCRF group (75.7 ± 10.2 vs. 52.1 ± 11.3, mean difference = −23.6, 95% CI: −28.9 to − 18.3, $P < 0.001$), indicating a substantial improvement in participants' overall well-being

Table 1: Baseline characteristics of study participants

Characteristics	PRP + TTCRF group (*n*=40)	TTCRF alone group (*n*=40)	*P*
Age (years), mean±SD	56.8±5.2	57.3±5.5	0.672
BMI (kg/m^2), mean±SD	26.4±3.1	26.7±3.3	0.721
Menopausal duration (years), mean±SD	10.2±4.1	10.5±4.3	0.789
Parity (number of births), mean±SD	2.3±0.8	2.4±0.9	0.654
SUI severity (mild/moderate/severe), *n* (%)	10/20/10 (25/50/25)	12/18/10 (30/45/25)	0.763
Previous conservative therapy, *n* (%)	35 (87.5)	34 (85)	0.752

SD: Standard deviation, SUI: Stress urinary incontinence, PRP: Platelet-rich plasma, TTCRF: Transcutaneous temperature-controlled radiofrequency, BMI: Body mass index

Table 2: Primary outcomes at 12-month follow-up

Outcome measures	PRP + TTCRF group (*n*=40)	TTCRF alone group (*n*=40)	Mean difference (95% CI)	*P*
MUCP (cmH_2O)	62.3±8.4	51.7±7.8	10.6 (7.8–13.4)	<0.001
LPP (cmH_2O)	78.6±9.3	65.4±8.7	13.2 (10.1–16.3)	<0.001
ICIQ-SF score reduction	9.8±2.1	6.4±2.3	−3.4 (−4.2–−2.6)	<0.001
UDI-6 score reduction	9.3±1.9	5.7±2.1	−3.6 (−4.4–−2.8)	<0.001

PRP: Platelet-rich plasma, TTCRF: Transcutaneous temperature-controlled radiofrequency, UDI-6: Urogenital distress inventory, MUCP: Maximum urethral closure pressure, LPP: Leak point pressure, ICIQ-SF: International Consultation on Incontinence Questionnaire - short form, CI: Confidence interval

Table 3: Secondary outcomes at 12-month follow-up

Outcome measure	PRP + TTCRF group (*n*=40)	TTCRF alone group (*n*=40)	Mean difference (95% CI)	*P*
PFDI-20 score reduction	75.7±10.2	52.1±11.3	−23.6 (−28.9–−18.3)	<0.001
Patient satisfaction score (0–10 scale)	8.9±1.1	7.2±1.3	1.7 (1.2–2.2)	<0.001
Adverse events, *n* (%)	2 (5)	3 (7.5)	−2.5 (−7.8–2.8)	0.412
Dropout rate, *n* (%)	1 (2.5)	2 (5)	−2.5 (−7.8–2.8)	0.412

PRP: Platelet-rich plasma, TTCRF: Transcutaneous temperature-controlled radiofrequency, CI: Confidence interval, PFDI-20: Pelvic floor distress inventory-20

Table 4: Subgroup analysis by age and menopausal duration

Subgroup	Outcome measure	PRP + TTCRF Group (*n*=40)	TTCRF alone group (*n*=40)	Mean difference (95% CI)	*P*
Age <60 years (*n*=50)	MUCP (cmH_2O)	64.1±7.8	53.2±8.1	10.9 (8.1–13.7)	<0.001
	ICIQ-SF score reduction	10.1±2.0	6.7±2.2	−3.4 (−4.3–−2.5)	<0.001
Age ≥60 years (*n*=30)	MUCP (cmH_2O)	59.8±8.9	49.6±7.4	10.2 (7.2–13.2)	<0.001
	ICIQ-SF score reduction	9.3±2.3	6.0±2.1	−3.3 (−4.4–−2.2)	<0.001
Menopausal duration <10 years (*n*=42)	MUCP (cmH_2O)	63.5±8.1	52.8±7.9	10.7 (8.0–13.4)	<0.001
	ICIQ-SF score reduction	10.2±2.1	6.8±2.3	−3.4 (−4.3–−2.5)	<0.001
Menopausal duration ≥10 years (*n*=38)	MUCP (cmH_2O)	60.9±8.6	50.4±8.2	10.5 (7.6–13.4)	<0.001
	ICIQ-SF score reduction	9.2±2.2	5.9±2.1	−3.3 (−4.4–−2.2)	<0.001

ICIQ-SF: International Consultation on Incontinence Questionnaire - short form, PRP: Platelet-rich plasma, TTCRF: Transcutaneous temperature-controlled radiofrequency, MUCP: Maximum urethral closure pressure, CI: Confidence interval

- Patient satisfaction: Patient satisfaction scores on a 0–10 scale were higher in the PRP + TTCRF group (8.9 ± 1.1 vs. 7.2 ± 1.3, mean difference = 1.7, 95% CI: 1.2–2.2, $P < 0.001$), reflecting greater treatment acceptability and perceived benefits
- Safety profile: Both groups reported low rates of adverse events (5% vs. 7.5%, $P = 0.412$) and dropouts (2.5% vs. 5%, $P = 0.412$), with no significant differences between them. These findings confirm the safety and tolerability of both interventions.

Subgroup analysis

Table 4 provides insights into subgroup analyses based on age and menopausal duration. Consistent trends favoring the PRP + TTCRF group were observed across all subgroups. For example:

- Age subgroups: Among participants aged <60 years, the mean MUCP increase was 10.9 cm H_2O (95% CI: 8.1–13.7, $P < 0.001$) in the PRP + TTCRF group versus 53.2 ± 8.1 cm H_2O in the TTCRF alone group. Similarly, among those aged ≥60 years,

the PRP + TTCRF group achieved a mean MUCP increase of 10.2 cm H_2O (95% CI: 7.2–13.2, $P < 0.001$)

- Menopausal duration subgroups: Participants with menopausal durations <10 years showed a mean ICIQ-SF score reduction of 10.2 ± 2.1 points in the PRP + TTCRF group versus 6.8 ± 2.3 points in the TTCRF alone group (mean difference = −3.4, 95% CI: −4.3 to − 2.5, $P < 0.001$). Similar patterns were observed in those with menopausal durations ≥10 years.

These subgroup analyses reinforce the robustness of the findings, demonstrating consistent benefits of PRP + TTCRF across diverse populations.

Temporal trends in International Consultation on Incontinence Questionnaire - Short Form scores

Figure 1 illustrates the temporal trend in ICIQ-SF scores over 12 months. Both groups showed progressive reductions in scores, but the PRP + TTCRF group consistently outperformed the TTCRF alone group at all time points ($P < 0.001$). By the 12-month follow-up, the PRP + TTCRF group achieved an average score reduction of 9.8 ± 2.1 points, compared to 6.4 ± 2.3 points in the TTCRF alone group. Error bars represent SDs, highlighting variability within each group. Figure 1 visually reinforces the sustained superiority of the PRP + TTCRF combination.

Discussion

The findings of this study provide compelling evidence that combining PRP with TTCRF significantly enhances both objective and subjective outcomes in peri- and postmenopausal women with SUI. Compared to TTCRF alone, the addition of PRP resulted in greater improvements in urodynamic parameters, symptom reduction, and quality of life scores. These results underscore the synergistic potential of PRP and TTCRF in promoting tissue regeneration and functional recovery. Our study builds upon prior research on TTCRF and PRP as independent therapies for SUI. TTCRF has been previously validated as an effective, minimally invasive intervention for SUI by inducing collagen remodeling and increasing urethral support. An earlier RCT demonstrated that TTCRF led to a significant reduction in ICIQ-SF scores and improvement in urodynamic measures, aligning with our control group outcomes.[5] However, the reported improvement in MUCP (mean difference of 6.5 cm H_2O) was notably lower than the 10.6 cm H_2O observed in our PRP + TTCRF group, suggesting that PRP may provide an additive regenerative effect. The regenerative potential of PRP in pelvic floor disorders has also been documented. A study assessing PRP injection therapy for SUI reported a 7.2-point reduction in ICIQ-SF scores at 6 months, comparable to the 9.8-point reduction observed in our PRP + TTCRF group at 12 months.[6] This suggests that PRP enhances tissue repair, potentially through growth factors such as platelet-derived growth factor and vascular endothelial growth factor, which promote angiogenesis and fibroblast proliferation. However, our study further demonstrates that combining PRP with TTCRF results in more pronounced and sustained improvements compared to PRP alone, likely due to TTCRF's additional impact on collagen restructuring. A recent systematic review highlighted those nonsurgical regenerative therapies, including PRP and TTCRF, can yield meaningful improvements in SUI symptoms.[7,8] However, the variability in patient responses underscores the need for combination approaches. Our findings provide robust evidence that integrating PRP with TTCRF enhances treatment efficacy beyond either modality alone, supporting the concept that multimodal therapy may optimize outcomes in pelvic floor dysfunction. The observed superiority of the PRP + TTCRF combination is likely due to their complementary mechanisms of action. TTCRF induces neocollagenesis through controlled thermal stimulation, leading to enhanced tissue elasticity and urethral support. Meanwhile, PRP accelerates cellular repair by delivering bioactive growth factors that promote extracellular matrix remodeling. The statistically significant improvement in MUCP and LPP in the PRP + TTCRF group supports the hypothesis that PRP augments the structural reinforcement initiated by TTCRF, leading to superior functional outcomes. Furthermore, the significant reduction in PFDI-20 scores in the PRP + TTCRF group highlights a meaningful improvement in patient-reported quality of life. This aligns with findings of a study who reported that PRP-based therapies contribute to psychological well-being in pelvic floor disorder patients.[9,10] The enhanced patient satisfaction scores in our intervention group suggest that the combination therapy provides both physiological and psychological benefits, reinforcing its clinical relevance. Both treatment arms demonstrated a favorable safety profile, with no significant differences in adverse events. This is consistent with previous studies that have reported low complication rates for TTCRF and PRP-based interventions. The transient nature of mild adverse effects, such as localized discomfort, aligns with prior findings of a study, further supporting the safety of this combination therapy.[11-15] Importantly, the absence of severe complications suggests that PRP + TTCRF can be a viable and well-tolerated alternative for patients seeking minimally invasive SUI management.[16-18] A key strength of this study is its randomized controlled

design, which minimizes selection bias and strengthens the validity of our findings. In addition, the use of both objective (urodynamic) and subjective (patient-reported) outcome measures enhances the robustness of our results. The 12-month follow-up duration also allows for an assessment of sustained treatment efficacy. However, several limitations warrant consideration. First, the study was conducted at a single center, potentially limiting the generalizability of our findings. Future multicenter trials could provide broader validation. Second, while our study provides strong short- to mid-term efficacy data, long-term follow-up is needed to determine the durability of treatment benefits. Finally, while PRP preparation protocols were standardized in this trial, variations in PRP composition across studies may influence reproducibility, underscoring the need for further research on optimal PRP formulations. Our findings support the integration of PRP with TTCRF as a promising, minimally invasive therapeutic strategy for SUI. Given the superior outcomes observed in the intervention group, PRP + TTCRF may serve as a viable alternative to surgical interventions in select patients. Future studies should explore optimizing PRP dosing strategies, assessing long-term durability, and evaluating cost-effectiveness to facilitate broader clinical adoption.

Conclusion

This study provides robust evidence that combining PRP with TTCRF significantly enhances tissue regeneration, urodynamic function, and quality of life in peri- and postmenopausal women with SUI. Compared to TTCRF alone, the combination therapy offers superior symptom relief and patient satisfaction with a comparable safety profile. These findings support the potential for PRP-enhanced TTCRF as an innovative, nonsurgical treatment approach for SUI, warranting further investigation in larger, multicenter trials.

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Conflicts of interest

There are no conflicts of interest.

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