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Short Communication

Improving pelvic floor muscle strength in women with postpartum stress urinary incontinence using electromagnetic stimulation therapy: A randomized controlled trial

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Abstract

Electromagnetic stimulation (EMS) has emerged as a potential alternative for managing urinary incontinence in women. However, research directly comparing EMS to Kegel exercises in cases of postpartum stress urinary incontinence (SUI) is limited. The aim of this study was to assess the effectiveness of EMS (improvement of the symptoms, incontinence severity and pelvic floor muscle strength) and patient compliance with the therapy in postpartum women with SUI. A single-blind randomized clinical trial was conducted involving postpartum women diagnosed with SUI at least three months after delivery. The EMS group received the therapy three times a week for five weeks, while the Kegel group was instructed to perform daily exercises for eight weeks. Improvement of the symptoms and incontinence severity were evaluated using the Urogenital Distress Inventory-6 (UDI-6) and a 1-hour pad test, respectively, while pelvic floor muscle strength was measured with a perineometer. Both groups showed significant improvements in UDI-6 scores, 1-hour pad test results and pelvic floor muscle strength compared to before treatment. However, the EMS group had significantly greater muscle strength than the Kegel group (16.5 vs 8.0 cmH_2O, p=0.006). The UDI-6 scores, 1-hour pad test results and patients' compliance were not significantly different between EMS and Kegel groups. EMS demonstrated a greater ability to enhance pelvic floor muscle strength than Kegel exercises. These findings suggest that EMS may be a more effective option for enhancing pelvic floor muscle strength in postpartum women.

Keywords: Postpartum, urinary incontinence, pelvic floor muscle training, electromagnetic therapy, pelvic floor

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Introduction

Stress urinary incontinence (SUI) is defined as the involuntary leakage of urine triggered by physical activities such as sneezing, coughing, or exertion [1]. Globally, SUI is a common condition, particularly in older women [2]. The global prevalence of SUI can reach up to 49%, influenced by demographic variations and geographical factors [1]. Contributing factors such as body mass index (BMI), parity, and mode of delivery—especially vaginal births—have been well-

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documented as risk factors associated with the development of SUI [3]. In Indonesia, SUI is prevalent among pregnant women, with reported prevalence estimates ranging from 14.7% to 52% [4]. Furthermore, childbirth has been recognized as a risk factor for the onset of urinary incontinence, with cases persisting up to three months postpartum [4].

The cornerstone of SUI management is pelvic floor muscle training (PFMT), commonly known as Kegel exercise, which aims to strengthen the pelvic floor musculature and improve bladder control [5]. Evidence from a systematic review demonstrated the efficacy of PFMT in improving SUI symptoms in 74% of participants [6]. Despite its efficacy, adherence to PFMT significantly influences outcomes [7]. A previous study reported an adherence rate of 81% to the PFMT program, indicating that nearly 20% of participants discontinued the study despite the intensive implementation of PFMT [8]. This suggests that while overall adherence was relatively high, individual compliance still varied among participants [8]. For individuals unable to sustain adherence or achieve desired outcomes with PFMT, alternative therapies are essential.

Electromagnetic stimulation (EMS) has emerged as a promising alternative intervention for SUI. This non-invasive modality involves stimulating pelvic floor muscles to improve their strength and functionality. A study has reported a 32.7% cure rate for SUI patients treated with EMS therapy [9]. Direct comparisons between EMS and Kegel exercises in postpartum SUI are limited. Key questions surrounding the comparative effectiveness, compliance rates, and patient satisfaction between these two approaches remain inadequately addressed in the literature.

Preliminary evidence suggests that EMS may offer advantages, including higher compliance rates and comparable improvements in pelvic floor muscle strength relative to Kegel exercises [9]. However, robust data evaluating these claims are scarce. Therefore, the aim of this study was to evaluate the effectiveness of EMS for SUI in postpartum women, compared to Kegel exercises, as a conservative therapy.

Methods

Study design and settings

This was a single-blinded, randomized clinical trial to compare the effectiveness of two different interventions (EMS vs PFMT) for postpartum women diagnosed with SUI. Participants were randomly assigned to one of two treatment groups and evaluated using predefined subjective (using Questionnaire of Urinary Incontinence Diagnosis (QUID)) and objective measurements (cough test and 1-hour pad test). The study was conducted at YPK Mandiri Hospital, a tertiary care center in Jakarta, Indonesia, over a one-year period from March 2020 to February 2021.

Sample size and sampling strategy

The sample size calculation was based on a type I error (α) of 5% and a type II error (β) of 10%, ensuring a statistical power of 90%. The sample size was determined using the formula for the difference between two proportions [10]. It was assumed that the expected compliance rate would be 90% for EMS and 60% for Kegel exercises, with a clinically significant difference of 40%. This resulted in a minimum requirement of 20 participants per group (a total of 40 samples). This estimation was based on a previous study that showed lower compliance with Kegel exercises, as patients often forgot to perform the exercises at home, executed the movements incorrectly, or failed to adhere to the prescribed protocol despite prior interventions and supervision [11]. In contrast, EMS was expected to have a higher compliance rate, as patients regularly visited the hospital for evaluations while sitting on the electromagnetic chair and performing PFMT. No additional samples were explicitly included to account for dropouts, as this sample size was deemed sufficient to maintain statistical power. However, potential dropouts were monitored throughout the study period. A consecutive sampling technique was employed in this study.

Patients and criteria

This study included postpartum women aged 20 years or older and were diagnosed with SUI at least three months postpartum. Eligibility was confirmed by the presence of urine leakage during a cough test when bladder volume ranged from 200 to 250 mL. Patients were also required to perform a 1-hour pad test. Bladder volume was measured using transabdominal ultrasound prior

to the cough test. However, if participants reported a strong urge to urinate, subjective confirmation was accepted instead. Women with mixed incontinence, pre-existing SUI before pregnancy, uncontrolled diabetes mellitus, grade 3 or 4 pelvic organ prolapse, chronic degenerative diseases, prior pelvic surgery, muscle or nerve trauma, or a pacemaker user, were excluded from the study. Patients were considered dropouts if they could not be contacted during the study period or voluntarily withdrew from the study at any time. Participants were randomly assigned to either the Kegel exercise or EMS group via simple computer-generated randomization.

Kegel exercise intervention

The Kegel exercise intervention was conducted over eight weeks, with patients in the exercise group instructed to perform daily sessions. To ensure correct execution of the exercises, participants were referred to a trained physiotherapist for individualized guidance, and their progress was monitored biweekly. The intervention incorporated two distinct training components: fast-twitch muscle training, involving two-second contractions followed by four seconds of rest, and slow-twitch muscle training, involving five-second contractions with ten-second rests. Each session consisted of five sets of five repetitions, taking approximately two minutes per set, totaling ten minutes per session. Adherence to the program was monitored through self-reported control cards and biweekly interviews, ensuring compliance and providing regular feedback. Participants were required to complete at least 80% of the prescribed sessions to be considered adherent, in line with the compliance threshold applied to the EMS group.

EMS intervention

The EMS intervention was administered using the NOVAMAG NT-60 magnetic chair (NOVAMedtek, Ankara, Turkey). Patients in the EMS group were positioned on the chair to ensure optimal alignment of the perineum with the magnetic field, specifically targeting the pelvic floor and sphincter muscles. The intervention comprised 15 therapy sessions, each lasting 20 minutes, conducted three times per week. However, unlike the Kegel exercise group, which underwent an eight-week intervention, the EMS group completed their sessions within a shorter five-week period. This difference in intervention duration is due to the lack of comparative studies determining the most effective frequency and duration for EMS. In this study, the EMS intervention duration was determined based on the usage criteria of the NOVAMAG NT-60 magnetic chair, which recommends three sessions per week for a minimum total of 15 stimulation (5–6 weeks) [10].

Data collection

This study utilized a structured data collection procedure to ensure accuracy and consistency in evaluating the intervention outcomes. The data included demographic characteristics, baseline clinical information, and key outcome measures assessed before and after the interventions. Data were obtained through patient interviews, standardized questionnaires, and objective tests. Baseline assessments included the Urogenital Distress Inventory-6 (UDI-6) questionnaire, a 1-hour pad test, and pelvic floor muscle strength evaluation using a Peritron perineometer (Cardio Design Pty Ltd, Victoria, Australia).

The intervention period differed between the two study groups. Participants in the EMS group underwent 15 sessions over 5 to 6 weeks (three sessions per week, each lasting 20 minutes), while those in the Kegel exercise group completed an 8-week protocol with daily at-home exercises monitored through patient logs. Patient adherence was monitored throughout the study. Compliance was defined as attending at least 80% of scheduled therapy sessions. Primary outcome variables included: subjective improvement in urinary incontinence symptoms, objective evaluation of incontinence severity, and pelvic floor muscle strength. All outcome assessments were conducted by trained medical professionals, including research assistants (general practitioners) and obstetricians from YPK Mandiri Hospital, Jakarta, Indonesia.

Endpoints

The primary outcomes in this study were: (1) subjective improvement in urinary incontinence symptoms; (2) objective evaluation of incontinence severity; and (3) pelvic floor muscle strength.

The secondary outcome was patient compliance with the therapy. Subjective improvement of urinary incontinence symptoms was evaluated using the UDI-6 questionnaire (83.33% sensitivity and 83.59% specificity) [12]. The UDI-6 questionnaire, originally developed by Mountain State Urogynecology, has been validated for its use in Indonesia [13]. The questionnaire consists of six items assessing the severity of urinary symptoms on a Likert scale (0–3). The total score was calculated by averaging the responses and multiplying by 25, yielding a final score range of 0–100, where a higher score indicates greater symptom severity.

The objective evaluation of incontinence severity was evaluated using a 1-hour pad test (95.65% sensitivity, 93.33% specificity, 97.34% positive predictive value, and negative predictive value 89.36%) [14]. The 1-hour pad test, following the Standardization Committee of the International Continence Society (ICS) guidelines [15], objectively quantifies urine leakage by measuring the difference in pad weight before and after a standardized physical activity protocol. Leakage severity was classified as mild (2–10 g), moderate (10–50 g), and severe (≥50 g). Symptom evaluations were conducted pre- and post-intervention, with blinded evaluators to minimize bias.

Pelvic floor muscle strength was measured using the Peritron perineometer, a reliable device for assessing muscle contractions. There is a stronger correlation between vaginal palpation and pressure measurement using a perineometer ranging between r=0.75 and r=0.86 [16]. Participants performed three consecutive contractions, each held for 2–3 seconds, and the highest value was recorded for analysis. Measurements were taken in centimeters of water (cmH_2O), before and after the intervention, by trained evaluators who were blinded to the group assignments. Compliance with the therapy regimen was closely monitored using attendance records, and patients attending fewer than 80% of the sessions were classified as non-compliant.

Statistical analysis

Statistical analysis followed the intention-to-treat principle, including all randomized participants in their originally assigned groups. Descriptive statistics were used to summarize baseline characteristics, with continuous variables presented as mean ± standard deviation for normally distributed data or as median with range for non-normal distributions. Categorical variables were expressed as frequencies and percentages. Normality was assessed using the Shapiro-Wilk test. For between-group comparisons, the Mann-Whitney U test was used. Categorical variables, such as compliance rates and improvements in urinary incontinence severity, were analyzed using the Chi-squared test.

The outcomes (UDI-6 scores, 1-hour pad test results and pelvic floor muscle strength) were analyzed within groups with the Wilcoxon signed-rank test for non-normal data. Post-intervention differences between groups were assessed using the Mann-Whitney U test. Compliance outcome was analyzed using the Wilcoxon signed-rank test. All analyses were performed using IBM SPSS Statistics (IBM Corp., Armonk, USA) version 21.0, with statistical significance set at p<0.05.

Results

Characteristics of the patients

A total of 51 patients were initially screened for eligibility. However, six patients were excluded due to a diagnosis of mixed urinary incontinence. Additionally, five participants dropped out, either because they did not attend the first session or were referred to a physiotherapist. As a result, 40 patients were included in the final analysis. The study selection process is illustrated in the CONSORT diagram (**Figure 1**).

The demographic and clinical characteristics of the study participants are summarized in **Table 1**. There were no significant differences between the two groups in terms of baseline characteristics. Most patients in both groups were aged 20–30 years, with 45% in the EMS group and 55% in the Kegel exercise group. Parity distribution was also similar, with a median parity of 2.0 in the EMS group and 4.0 in the Kegel group, showing no significant difference. Regarding educational background, a higher proportion of university-educated patients was observed in the EMS group (65%) compared to the Kegel group (30%), though this difference was not statistically

significant. Nutritional status analysis showed that most patients in both groups were either overweight or obese, with no significant differences in BMI. In terms of delivery history, the majority of patients in both groups had spontaneous vaginal deliveries. The distribution of perineal ruptures was also similar, with 80% in each group experiencing grade 1–2 perineal rupture. Additionally, the second stage of labor duration and neonatal birth weight were comparable between the two groups, with 60% of patients in each group having a second stage lasting less than one hour.

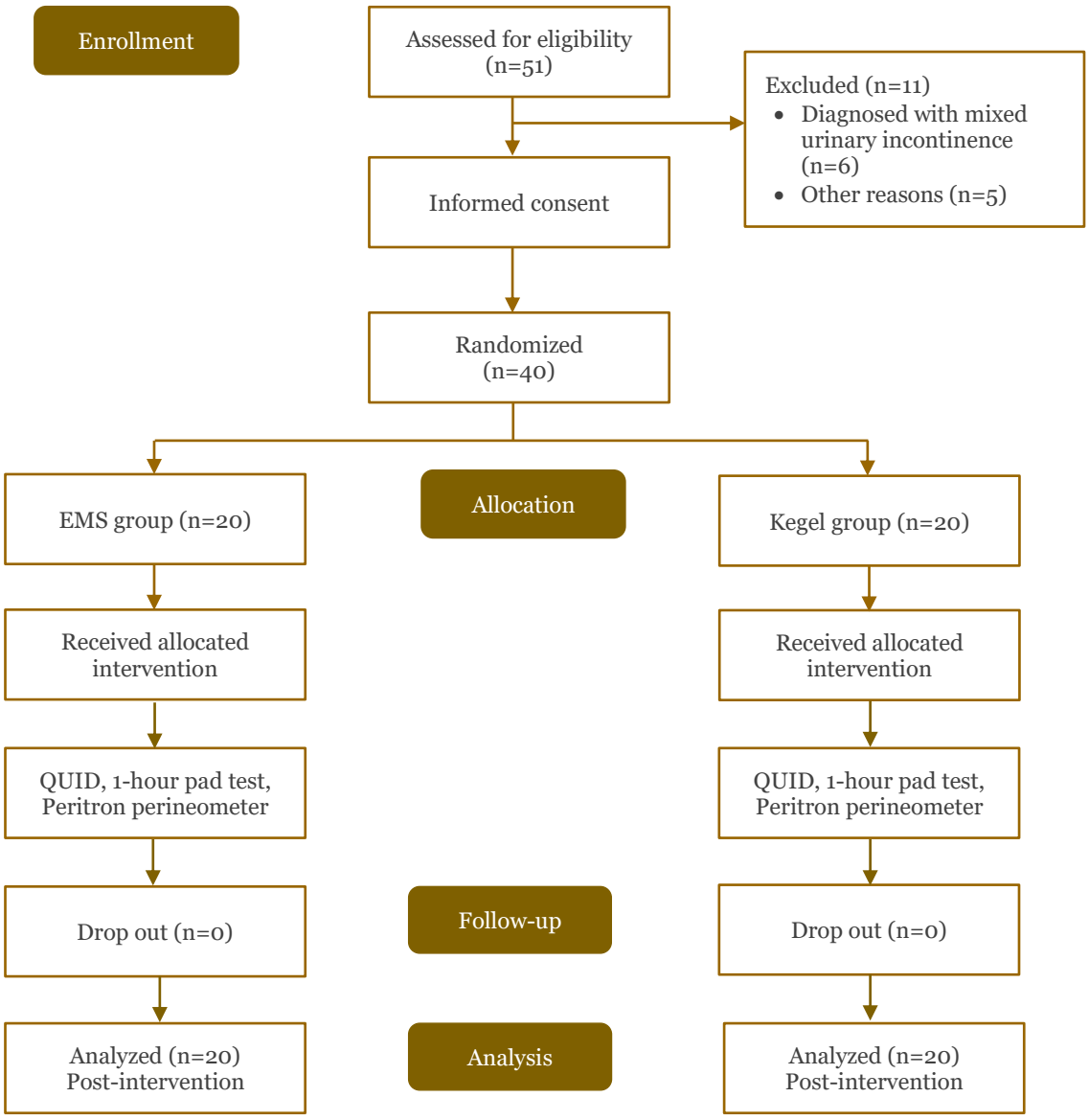

Figure 1. CONSORT flow diagram of the study.

Comparison of symptom improvements between EMS and Kegel exercises

EMS and Kegel exercise groups showed significant improvements in SUI symptoms before and after the intervention. The UDI-6 score significantly decreased in both groups ($p<0.001$), from a median of 20.8 (8.3–75) to 8.3 (0–20.8) in the EMS group, and from 29.2 (8.3–75) to 14.6 (0–50) in the Kegel group (**Table 2**). Similarly, the 1-hour pad test showed a significant reduction in urinary leakage ($p<0.001$), from 4.0 (3–7) g to 1.0 (0–2) g in the EMS group, and from 3.5 (3–8) g to 1.0 (0–2) g in the Kegel group (**Table 2**). However, no statistically significant difference was observed in the reduction of UDI-6 scores ($p=0.555$) or 1-hour pad test results ($p=0.450$) between EMS and Kegel groups (**Table 2**). Additionally, no serious adverse effects were reported during the study.

Table 1. Characteristics of postpartum patients with stress urinary incontinence (SUI) included in the study (n=40)

Characteristics	EMS group (n=20)	Kegel group (n=20)	*p*-value
	Frequency (%)	Frequency (%)	
Age			
20–30 years old	9 (45)	11 (55)	0.527[a]
31–40 years old	11 (55)	9 (45)	
Parity			
Primipara	7 (35)	6 (30)	
Secondary parity	8 (40)	8 (40)	0.920[a]
Multipara	5 (25)	6 (30)	
Parity, median (min-max)	2.0 (1–4)	4.0 (1–5)	0.637[b]
Education			
Elementary school	0 (0)	0 (0)	
Junior high school	2 (10)	6 (30)	0.072[a]
Senior high school	5 (25)	8 (40)	
University	13 (65)	6 (30)	
Nutritional status			
Underweight	0 (0)	0 (0)	
Normoweight	4 (20)	4 (20)	0.766[a]
Overweight	11 (55)	9 (45)	
Obese	5 (25)	7 (35	
Mode of delivery			
Spontaneous	18 (90)	17 (85)	>0.999[a]
Vacuum extraction	2 (10)	3 (15)	
Forceps extraction	0 (0)	0 (0)	
Perineal rupture			
Grade 1–2	16 (80)	16 (80)	--
Grade 3–4	4 (20)	4 (20)	
Second stage duration			
<1 hour	12 (60)	12 (60)	--
>1 hour	8 (40)	8 (40)	
Birthweight (grams)			
<2500	0 (0)	0 (0)	>0.999[a]
2500–3999	20 (100)	19 (95)	
≥4000	0 (0)	1 (5)	

EMS: electromagnetic stimulation
[a]Analyzed using Chi-squared test
[b]Analyzed using Mann-Whitney test

Table 2. Comparison of symptom improvement of EMS and Kegel exercises based on the UDI-6 questionnaire and the 1-hour pad test

Outcome	Timeframe	Groups		*p*-value[a]
		EMS (n=20)	Kegel exercise (n=20)	
UDI-6 score	Within therapy			
	Before, median (min-max)	20.8 (8.3–75)	29.2 (8.3–75)	
	After, median (min-max)	8.3 (0–20.8)	14.6 (0–50)	
	p-value[b]	<0.001	<0.001	
	Between therapy	14.6 (0–58.3)	14.6 (4.2–29.2)	0.555
1-hour pad test	Within therapy			
	Before, median (min-max)	4.0 (3–7)	3.5 (3–8)	
	After, median (min-max)	1.0 (0–2)	1.0 (0–2)	
	p-value[b]	<0.001	<0.001	
	Between therapy	3.0 (2–6)	3.0 (1–7)	0.450

EMS: electromagnetic stimulation; UDI-6: Urogenital Distress Inventory-6
[a]Analyzed using Mann-Whitney U test; comparison between EMS and Kegel exercise groups
[b]Analyzed using Wilcoxon rank test; comparison between before and after therapy within EMS or Kegel exercise group

Comparison of pelvic floor muscle strength between EMS and Kegel exercises

A comparative analysis of pelvic floor muscle strength between the EMS and Kegel exercise groups showed significant improvement in both groups before and after the intervention. In the EMS group, the median muscle strength increased from 20 (14–42) cmH_2O to 37.5 (21–68) cmH_2O after the intervention ($p<0.001$) (**Table 3**). Similarly, in the Kegel exercise group, the median muscle strength improved from 18.5 (15–39) cmH_2O to 29 (21–41) cmH_2O ($p<0.001$).

However, the EMS group had a greater increase in vaginal muscle strength compared to the Kegel exercise group. Statistical analysis using the Mann-Whitney U test revealed a significant difference between the two groups (16.5 (0–41) cmH_2O vs 8.0 (0–18) cmH_2O; p=0.006) (**Table 3**).

Table 3. Comparison of Peritron perineometer measurements of EMS and Kegel exercises in postpartum stress urinary incontinence (SUI)

Timeframe	Groups		*p*-value[a]
	EMS (n=20)	Kegel exercise (n=20)	
Within therapy			
Before, median (min-max)	20 (14–42)	18.5 (15–39)	
After, median (min-max)	37.5 (21–68)	29 (21–41)	
p-value[b]	<0.001	<0.001	
Between therapy	16.5 (0–41)	8.0(0–18)	0.006

EMS: electromagnetic stimulation
[a]Analyzed with Mann-Whitney U test; comparison between EMS and Kegel exercise groups
[b]Analyzed with Wilcoxon rank test; comparison between before and after therapy within EMS or Kegel exercise group

Patient compliance in implementing therapy

All participants in the EMS group successfully completed the 15-session protocol within 5 to 6 weeks. In contrast, two patients (10%) in the Kegel exercise group were unable to fully adhere to the prescribed regimen due to childcare responsibilities and work commitments (**Table 4**). Compliance rates between the EMS and Kegel exercise groups were compared using the Wilcoxon rank test, which indicated no statistically significant difference between the two groups (**Table 4**).

Table 4. Comparison of therapy compliance between EMS and Kegel exercise groups

Groups	Compliance		*p*-value[a]
	Complete	Incomplete	
Electromagnetic stimulation (EMS)	20	0	0.487
Kegel exercise	18	2	

[a]Analyzed using Wilcoxon signed-rank test

Discussion

EMS and Kegel exercises are well-established conservative therapies for patients with SUI; however, no studies have directly compared these two management approaches. The success of these therapies is closely linked to patient motivation and compliance. A previous study has shown that long-term adherence to Kegel exercise or PFMT method can be challenging [17]. In addition, there are only a limited number of studies that compare the compliance rates, effectiveness, and improvements in pelvic floor muscle strength following treatment with EMS. Unlike Kegel exercises, there has been no comparative study of the most effective time for the frequency and duration of EMS. Referring to previous studies on EMS regimens [18-20], this study adopted a similar regimen, 20 minutes of stimulation, three sessions/week with a total of 15 sessions. However, an innovation was introduced to determine the optimal frequency for each patient. Initially, the frequency was set at 30% of maximal power and increased by 10% every 30 seconds if the patient felt comfortable. The remaining time was completed using the maximum power that the patients could tolerate.

This study showed that the EMS group successfully completed the full course of treatment according to the scheduled 5-week plan, whereas in the Kegel exercise group, two patients did not comply with the prescribed regimen (<80% adherence). The reasons for the decreased compliance in this study included sick children and other work-related responsibilities, which led to forgetfulness in following the Kegel exercise routine. Several strategies have been proposed to improve compliance in PFMT programs, such as more intensive programs, appropriate follow-up, and more feasible treatment options [21,22]. Despite these challenges, no significant difference in compliance rates was observed between the EMS and Kegel groups.

The results showed a significant improvement in UDI-6 scores and 1-hour pad test for both groups, and there was no significant difference between groups. A study found that EMS therapy reduced the UDI-6 score from 40.28 to 30.55 (p<0.05) and pad weight from 19.73 to 4.98 (p<0.05)) [23]. Another study also reported an improvement in the 1-hour pad test, from 6.28 g to 3.31 g (p=0.01) [24]. However, there was no significant difference in the improvement between Kegel exercises and EMS. Both groups showed similar improvements, with a 14.6-point reduction in the UDI-6 score and a 3.0 g reduction in the 1-hour pad test. Furthermore, the EMS group achieved comparable improvements in a shorter amount of time and with fewer sessions than the Kegel exercise group.

EMS generates a homogeneous magnetic field that stimulates muscle contractions through random recruitment [23]. The magnetic field induces the flow of ions, propagating an electric current that leads to the release of acetylcholine. This results in depolarization of the muscle fibers, causing muscle contraction and stimulating Kegel therapy [25,26]. Additionally, EMS may increase collagen levels by activating T-type calcium channels and opening the TGF-β1-Smad2/3 pathway during mechanical strain [27]. Ultimately, enhanced collagen formation and strengthening the pelvic floor muscles can reduce urine leakage. However, as with other skeletal muscles, pelvic floor muscles can lose strength if not regularly exercised. Therefore, after EMS therapy, regular exercises are essential to sustain pelvic floor muscle strength.

Our study also found that both groups showed significant improvements in pelvic floor muscle strength after treatment. In the Kegel exercise group, the improvement was from 18.5 cmH_2O to 29 cmH_2O (p<0.05), and in the EMS group, from 20 cmH_2O to 37.5 cmH_2O (p<0.05). These results were consistent with those of other studies. A previous study found a significant improvement in pelvic muscle strength in the Kegel exercise group, from 9.8 cmH_2O to 20.3 cmH_2O (p<0.05) [23], and another study found an improvement from 20.21 mmHg to 25.73 mmHg (p<0.05) [28]. EMS also showed a statistically greater improvement than Kegel exercises (p<0.05). However, the endurance of pelvic floor muscle contractions, which is also an important parameter in pelvic floor function, was not measured in this study.

The limitations of this study included the short duration, reliance on self-reported Kegel exercise with only eight weeks of exercise instead of twelve weeks, and the inability of the perineometer to measure pelvic floor muscle endurance or account for abdominal pressure. Nevertheless, this study is the first to assess adherence, effectiveness, and pelvic floor muscle strength of two modalities for SUI in the Indonesian population. The findings may help clinicians formulate therapies that require a high level of compliance. Further research is needed to determine the optimal duration and frequency of EMS, examine the long-term effects of both therapies (six months to one year post-therapy), and conduct follow-up studies that explore additional factors or variables such as sexual function and quality of life.

Conclusion

Our study found no differences in adherence between EMS and Kegel exercises. Both therapies significantly improved symptoms as measured by UDI-6, the 1-hour pad test and pelvic floor muscle strength. While improvements in UDI-6 scores and 1-hour pad test results were similar between the groups, the EMS group had a significantly greater increase in pelvic floor muscle strength compared to the Kegel group. This study indicates that EMS therapy may serve as an alternative for women who are unable to perform or adhere to Kegel exercises. However, to maintain long-term pelvic floor strength, continued practice of Kegel exercises after completing EMS therapy is recommended.

Ethics approval

This study was approved by the Health Research Ethics Committee of the Faculty of Medicine, Universitas Indonesia (Approval Number: KET-713/UN2.F1/ETIK/PPM.00.02/2020). All participants provided informed consent before enrollment in the study, and all procedures were conducted in accordance with the ethical guidelines of the Declaration of Helsinki.

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Competing interests

The authors declare no conflicts of interest.

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Underlying data

The datasets utilized and analyzed during this study can be obtained from the corresponding author upon reasonable request.

Declaration of artificial intelligence use

The authors confirm that no artificial intelligence (AI) tools or methodologies were employed at any stage of this study, including data collection, analysis, visualization, or manuscript preparation. All work presented in this study was conducted manually by the authors without the assistance of AI-based tools or systems.

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