ORIGINAL RESEARCH

The Clinical Significance of Real-Time 3-D Transperineal Ultrasound in the Treatment of Postpartum Pelvic Floor Dysfunction Using a Combined Magnetic and Electrical Repair Approach

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ABSTRACT

Objective • This study aims to evaluate the clinical significance of using real-time three-dimensional transperineal ultrasound in conjunction with a combined magnetic and electrical repair approach for the treatment of postpartum pelvic floor dysfunction.

Methods • Ninety patients with postpartum pelvic floor dysfunction were included and randomly assigned to the control or the observation group. The control group received Kegel pelvic floor rehabilitation training, while the observation group underwent real-time three-dimensional transperineal ultrasound examination, along with the training. Following assessment tools were used: Modified Oxford Scale (MOS) assessed pelvic floor muscle (PFM) strength and function; Pelvic Floor Distress Inventory (PFDI-20) questionnaire assessed the distress and discomfort reported by patients concerning symptoms of genital prolapse, anal colorectal symptoms, and urinary symptoms; Pelvic Floor Impact Questionnaire (PFIQ-7) measured the impact of urinary, colorectal-anal, and genital prolapse symptoms on patients' activities, relationships, and feeling; and International Consultation on Incontinence Questionnaire (ICIQ) was utilized to assess urinary incontinence (UI) symptoms and their impact on an individual's quality of life (QoL). It was developed by an international committee of experts in the field of incontinence research and is available in multiple languages. ICIQ-UI Short Form focuses on the symptoms of urinary incontinence. It assesses the type, frequency, and amount of urine leakage, as well as the impact of UI on daily activities, such as work, social interactions, and emotional well-being. It also includes questions about the use of protective pads or aids.

Results • The results showed significant improvements in pelvic floor muscle strength, symptom distress, and impact on activities, relationships, and feelings in the observation group compared to the control group. The MOS scores significantly increased in the observation group ($P < .001$), indicating improved PFM strength. The PFDI-20 scores significantly decreased in the observation group ($P < .001$), indicating reduced distress related to pelvic floor dysfunction symptoms. The PFIQ-7 scores also showed significant improvements in the observation group, indicating reduced impact on activities, relationships, and feelings. The ICIQ scores significantly decreased in the observation group, indicating reduced severity of UI symptoms and improved QoL.

Conclusion • The findings of the study suggest that this innovative therapeutic strategy can be a potentially effective therapeutic option for postpartum pelvic floor dysfunction and has prospects for clinical implementation. (*Altern Ther Health Med.* [E-pub ahead of print.])

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INTRODUCTION

Postpartum pelvic floor dysfunction (PFD) is a common condition that affects a significant number of women following childbirth.[1] It encompasses various symptoms, including urinary incontinence, pelvic organ prolapse, and sexual dysfunction, which can have a profound impact on a woman's quality of life and overall well-being.[2-4] Several treatment approaches, ranging from conservative measures to surgical interventions, have been developed to address these issues.[5] However, there is a need for further research to explore innovative and effective therapeutic strategies.

Real-time three-dimensional transperineal ultrasound has emerged as a valuable tool for evaluating the structure and function of the pelvic floor muscles.[6] This non-invasive imaging technique provides dynamic visualization, allowing for the assessment of muscle strength, integrity, and coordination.[7] By identifying specific areas of dysfunction, real-time three-dimensional transperineal ultrasound can help guide targeted treatment interventions. In recent years, a combined magnetic and electrical repair approach has shown promise in the treatment of postpartum PFD. This approach involves the application of magnetic stimulation and electrical stimulation to the pelvic floor muscles.[8] Magnetic stimulation aims to activate and strengthen the muscles, while electrical stimulation promotes neuromuscular re-education and enhances treatment effectiveness.[9] However, more research is needed to evaluate the clinical significance and effectiveness of this combined approach.

The purpose of this study is to assess the clinical significance of using real-time three-dimensional transperineal ultrasound in conjunction with the combined magnetic and electrical repair approach for the treatment of postpartum PFD. This study aims to fill a gap in the existing literature by exploring the clinical utility of real-time three-dimensional transperineal ultrasound and the combined magnetic and electrical repair approach for postpartum PFD. By evaluating the effectiveness of this innovative therapeutic strategy, we aim to contribute to the development of evidence-based treatment options and improve patient outcomes. We hypothesize that the combined magnetic and electrical repair approach, guided by real-time three-dimensional transperineal ultrasound, will lead to significant improvements in pelvic floor muscle function and patient-reported outcomes in women with postpartum PFD.

MATERIAL AND METHODS

Participants

Ninety patients with PFD treated in the gynecology department of Northwest Women's and Children's Hospital were included in this study. The patients were randomly assigned into two groups, with 45 patients in each group, using a random number table generated by SPSS 23.0 (IBM Corp., Armonk, NY, USA). Before enrollment, patients provided informed consent. The study protocol was approved by the hospital ethics committee (No. 2020093), and all procedures adhered to the ethical guidelines outlined in the Declaration of Helsinki for clinical research. The patient profile is shown in Table 1.

Inclusion and exclusion criteria

Inclusion Criteria: (i) Women who meet the criteria for assessing pelvic floor dysfunction, including the presence of class I and class II pelvic floor muscle fibers with muscle strength ≤ grade 3 and physical impairment caused by pelvic floor disorders.[9] (ii) Uncomplicated vaginal delivery. (iii) Singleton full-term pregnancy (recently delivered).

Exclusion Criteria: (i) Mental or cognitive impairment. (ii) Inability to cooperate with the study requirements. (iii) Severe cardiac, hepatic, or renal dysfunction. (iv) Pregnancy complications (such as gestational diabetes, preeclampsia, placenta previa, etc.). (v) Presence of gynecological oncological disease.

Table 1. Comparison of Participant Data

	Experimental group	Control group	t/χ^2	*P* value
n	45	45		
Age (years)	27.86 ± 3.23	27.26 ± 3.24	0.049	.961
Duration of symptoms (months)	2.42 ± 0.79	2.14 ± 1.17	2.064	.356
Week of gestation at delivery	39.47 ± 0.36	39.26 ± 0.42	0. 054	.874
Primipara	24	31	0. 816	.861
Multiparous	21	14	0. 123	.902
Stress incontinence	26	28	0. 736	.835
Sexual dysfunction	9	8	0. 241	.928
Uterine prolapse	10	9	0. 825	.847

Intervention methods

Control Group: The control group received Kegel pelvic floor rehabilitation training, which involved health education provided by healthcare professionals and guidance on performing Kegel pelvic floor exercises. The patients were instructed to empty their bladder and assume positions such as supine, standing, or sitting. Under the guidance of healthcare professionals, they performed pelvic floor muscle contractions, which involved actively contracting the anal, vaginal, and urethral muscles while inhaling, with the relaxation of the abdominal and gluteal muscles during inhalation. They were instructed to maintain the contraction for at least 3 seconds and then slowly exhale and relax the muscles, followed by a 10-second rest period. The exercise was repeated, and as proficiency increased, the contraction time was extended to at least 10 seconds. Each exercise session lasted at least 15 minutes, and the recommended frequency was three times per day for a total of eight weeks.

Experimental Group: In addition to the interventions received by the control group, the observation group underwent real-time three-dimensional perineal ultrasound examination. The instrument used for the examination was a real-time three-dimensional color ultrasound with a DE10-3U transducer, operating at a frequency of 2-9 MHz. To ensure consistency, all examinations were performed by the same ultrasound physician. The examination method involved the patient emptying their bowels and having a residual urine volume of less than 50 mL, assuming the lithotomy position. The transducer was placed 10 mm from the midpoint between the vaginal and urethral orifices, obtaining a mid-sagittal section of the pelvic floor, with imaging ranging from the inner to outer aspects of the abdomen. Using a reference line formed by a 45° angle connecting the midpoint of the pubic symphysis and the lower edge of the pubic bone, measurements were taken for bladder neck position, bladder neck mobility, bladder neck angle, thickness of the puborectal muscle, and area of the puborectal muscle hiatus. The patient was then instructed to perform a Valsalva maneuver, and the above measurements were taken again. The reference values were as follows: bladder neck position below 0-1 cm from the reference line indicated mild prolapse, and greater than 1 cm indicated significant prolapse. A bladder neck angle of ≥140° indicated enlargement and a puborectal muscle hiatus area of >20 cm² during the Valsalva maneuver indicated enlargement.

PFD patients received a combined magnetic and electrical repair approach using an instrument manufactured by Nanjing Weisi Technology Co., Ltd. Pelvic floor muscle electrical stimulation was administered 2-3 times per week, with each treatment session lasting 30 minutes. Pelvic floor muscle magnetic stimulation was also administered 2-3 times per week, with each session lasting approximately 20 minutes. The magnetic stimulation was performed after the electrical stimulation. After 8 weeks of treatment, a follow-up real-time three-dimensional perineal ultrasound examination was conducted.

Outcome measures

PFM Strength and Function: Assessed by digital palpation using the Modified Oxford Scale (MOS) proposed by Laycock.[10] It consists of five grades: Grade 0: No contraction or muscle activity is detected. Grade 1: A flicker or trace of muscle contraction is felt, but it is weak and barely noticeable. Grade 2: A weak muscle contraction is felt and can be elicited voluntarily, but it lacks strength. Grade 3: A moderate muscle contraction is felt, which is considered normal. Grade 4: A strong and robust muscle contraction is felt, indicating excellent PFM strength.

Pelvic Floor Distress Inventory (PFDI-20):[11] Consists of 20 questions divided into three symptom scales. Questions 1-6 assess genital prolapse symptoms (POPDI), questions 7-14 assess anal colorectal symptoms (CRADI), and questions 15-20 assess urinary symptoms (UDI). Participants rate the degree to which these symptoms are bothersome on a Likert-type scale ranging from 1 (not at all) to 4 (very much).

Pelvic Floor Impact Questionnaire (PFIQ-7):[11] Comprises 7 items that evaluate the impact of urinary (UIQ), colorectal-anal (CRAIQ), and genital prolapse (POPIQ) symptoms on activities, relationships, and feelings. Participants rate the impact on a Likert-type scale ranging from 0 (not at all) to 3 (very much).

International Consultation on Incontinence Questionnaire (ICIQ) [12]: Assesses the severity of specific urinary incontinence (UI) symptoms and their impact on quality of life (QoL). The ICIQ-UI SF score ranges from 0 to 21 and is the weighted sum of three items addressing urinary incontinence frequency ("how often do you leak urine?" 0=never to 5=all the time), leakage quantity ("how much urine do you usually leak?" 0=none to 6=a large amount), and interference with everyday life (0=not at all to 10=a great deal). Higher scores reflect greater severity.

Efficacy in this study was assessed using a self-designed questionnaire. The following criteria were used to determine the efficacy of the intervention:

Cure: Complete disappearance of urinary incontinence and associated symptoms, with no recurrence and a remission rate of more than 90%.

Effective: Significant improvement in symptoms, with a remission rate ranging from 75% to 90%.

Partially effective: Some reduction in symptoms, with a remission rate ranging from 30% to 75%.

Ineffective: No significant improvement in symptoms, with a remission rate of less than 30%.

The complications, including urinary incontinence, pelvic organ prolapse, lumbosacral pain, and urinary retention, were tracked and measured using various methods in the study.

Statistical analysis

SPSS 23.0 statistical software was used to process the data. Count data were expressed as N (%), the χ^2 test was applied, and measurement data were expressed as mean ± standard deviation (Mean ± SD). Independent sample *t* test was used for comparison between groups and paired sample *t* test was used for comparison within groups. Differences were indicated as statistically significant at $P < .05$.

RESULTS

Pelvic floor muscle strength

Pelvic floor muscle strength was significantly better in the experimental group than in the control group ($P < .05$), see Tables 2A and 2B.

Comparison of pelvic floor dysfunction

Before the intervention, there was no significant difference in PFDI-20 and PFIQ-7 scores ($P > .05$); after the intervention, the scores in both groups reduced significantly, with significantly lower scores in the treatment than the control group ($P < .05$), see Table 3.

Severity of urinary incontinence (UI)

The ICIQ-SF score for patients in the control group after intervention was (11.61±1.14) points, which was significantly lower compared to the pre-intervention score of (16.03±1.24) points ($P < .05$). The ICIQ-SF score for patients in the

Table 2A. Pelvic Floor Muscle Strength Analysis

Group	Cases	Before intervention			
		0 level	I~II level	III~IV level	V level
Experimental group	45	24	18	3	0
Control group	45	27	16	2	0
Z		0.668			
P value		.674			

Group	Cases	After intervention			
		0 level	I~II level	III~IV level	V level
Experimental group	45	0	1	8	36
Control group	45	0	3	18	24
Z		3.327			
P value		<.01			

Table 2B. Muscle Fibers Analysis

Group	Cases	Class I muscle fibers		Class II muscle fibers	
		Muscle voltage (μV)	Fatigue (%)	Muscle voltage (μV)	Fatigue (%)
Experimental group	45	8.31 ± 1.42	0.18 ± 0.04	8.26 ± 1.37	0.17 ± 0.01
Control group	45	5.86 ± 1.14	0.26 ± 0.02	5.34 ± 1.83	0.21 ± 0.02
Z		7.976	14.033	7.283	16.971
P value		<.01	<.01	<.01	<.01

Table 3. Comparison of Pelvic Floor Dysfunction ($\bar{x} \pm s$, Points)

Group	PFDI-20		PFIQ-7	
	Before intervention	After intervention	Before intervention	After intervention
Experimental group (n = 45)	33.69 ± 4.21	10.26 ± 1.89[a]	27.46 ± 3.07	14.06 ± 1.24[a]
Control group (n = 45)	34.29 ± 3.17	18.96 ± 1.62[a]	28.23 ± 2.51	17.94 ± 1.62[a]
t	0.047	7.432	0.042	7.814
P value	.267	<.01	.754	<.01

[a]Comparison with pre-intervention, $P < .05$

Table 4. Effective Rate of Treatment [n(%)]

Group	Cases	Cure	Effective	Ineffective	Total efficiency (%)
Experimental group	45	22	18	5	88.89%
Control group	45	15	20	10	77.78%

Table 5. Complications (n)

Group	Cases	Urinary incontinence	Pelvic organs prolapse	lumbosacral pain	Urinary retention	Total
Experimental group	45	2	1	3	2	8
Control group	45	4	2	4	4	14
χ^2						4.721
P value						.027

experimental group after intervention was (8.61±1.04) points, which was significantly lower compared to the pre-intervention score of (15.08±1.25) points, with a statistically significant difference ($P < .05$). In addition, the experimental group showed significantly lower post-intervention scores in comparison to the control group ($P < .05$).

Comparison of clinical efficacy

The effective rate of treatment of the experimental group was significantly higher than that of the control group at 88.89% and 77.78%, respectively ($P < .05$). See Table 4.

Comparison of complications

Complications were significantly lower in the experimental group than in the control group ($P < .05$) following the intervention. See Table 5.

DISCUSSION

The purpose of this study was to assess the clinical significance of using real-time three-dimensional transperineal ultrasound in conjunction with the combined magnetic and electrical repair approach for the treatment of postpartum pelvic floor dysfunction.

The results of this study revealed significant improvements in pelvic floor muscle strength, symptom distress, and impact on activities, relationships, and feelings in the observation group compared to the control group. These findings suggest that the combined approach of real-time three-dimensional transperineal ultrasound and a magnetic and electrical repair technique holds promise in effectively treating postpartum pelvic floor dysfunction. Firstly, the significant increase in MOS scores in the observation group indicates improved PFM strength. The utilization of real-time three-dimensional transperineal ultrasound may have facilitated more accurate assessment and targeted rehabilitation of the pelvic floor muscles. This finding aligns with previous studies that have demonstrated the efficacy of ultrasound-guided interventions in enhancing pelvic floor muscle function.[13] Secondly, the significant decrease in PFDI-20 scores suggests a reduction in distress related to pelvic floor dysfunction symptoms in the observation group. The real-time visualization provided by three-dimensional transperineal ultrasound may have aided in identifying and addressing specific anatomical and functional abnormalities, allowing for more personalized and effective treatment. Similar results have been reported in studies investigating the impact of ultrasound-guided interventions on symptom distress in pelvic floor disorders.[14,15] Thirdly, the significant improvements observed in PFIQ-7 scores indicate a reduced impact of urinary, colorectal-anal, and genital prolapse symptoms on activities, relationships, and feelings in the observation group. The combination of real-time imaging and the magnetic and electrical repair approach may have contributed to a more comprehensive and tailored treatment, targeting specific areas of dysfunction and minimizing the impact of symptoms on patients' daily lives. These findings corroborate previous research highlighting the positive effects of ultrasound-guided interventions on the functional and psychosocial aspects of pelvic floor disorders.[16] Furthermore, the significant decrease in ICIQ-SF scores in the observation group suggests a reduction in the severity of UI symptoms and an improvement in quality of life. The real-time visualization provided by three-dimensional transperineal ultrasound may have allowed for a more accurate assessment of UI symptoms and facilitated the selection of appropriate treatment strategies. These results are consistent with studies demonstrating the effectiveness of ultrasound-guided interventions in managing UI and enhancing QoL in patients with pelvic floor dysfunction.[15,17]

The combined magnetic and electrical repair approach involves the application of magnetic stimulation and electrical stimulation to the pelvic floor muscles. Magnetic stimulation aims to activate and strengthen the muscles, while electrical stimulation promotes neuromuscular re-education and enhances treatment effectiveness.[13] Real-time three-dimensional transperineal ultrasound serves as a valuable tool for evaluating the structure and function of the pelvic floor muscles, providing dynamic visualization, and allowing for the assessment of muscle strength, integrity, and coordination.[14] By identifying specific areas of dysfunction, this imaging technique can guide targeted treatment interventions.

The improved outcomes observed in the experimental group can be attributed to several factors. First, the magnetic and electrical repair approach directly targets the pelvic floor muscles, promoting their activation, strengthening, and neuromuscular re-education. This comprehensive treatment strategy addresses the underlying muscular dysfunctions associated with postpartum pelvic floor dysfunction.[15] Second, real-time three-dimensional transperineal ultrasound enables accurate assessment and monitoring of the pelvic floor muscles throughout the treatment process. This allows healthcare professionals to tailor the treatment approach based on individualized patient needs and track the progress of muscle function improvement.[16] The dynamic visualization provided by ultrasound helps guide the application of magnetic and electrical stimulation to the specific areas of dysfunction, maximizing the therapeutic effects.[17] Furthermore, the combination of real-time three-dimensional transperineal ultrasound and the magnetic and electrical repair approach offers a holistic approach to postpartum pelvic floor dysfunction.[18] It addresses not only the physical aspects of muscle strength and integrity but also the functional aspects of coordination and overall well-being of patients. By targeting both the structural and functional components of pelvic floor dysfunction, this combined approach provides a more comprehensive and effective treatment option.[19,20]

The implications of this study are significant for the management and treatment of postpartum pelvic floor dysfunction. The findings suggest that the combination of real-time three-dimensional transperineal ultrasound and the magnetic and electrical repair approach holds promise as an innovative and effective therapeutic strategy. Firstly, the use of real-time three-dimensional transperineal ultrasound provides a non-invasive and dynamic assessment of the pelvic floor muscles, allowing for targeted treatment interventions. This imaging technique can aid healthcare professionals in accurately identifying areas of dysfunction and tailoring treatment plans accordingly. Incorporating real-time ultrasound into clinical practice may improve the precision and effectiveness of treatment for postpartum pelvic floor dysfunction. Secondly, the combined magnetic and electrical repair approach offers a comprehensive treatment modality that addresses both the structural and functional aspects of pelvic floor dysfunction. By employing magnetic stimulation and electrical stimulation, this approach aims to activate, strengthen, and re-educate the pelvic floor muscles. The positive outcomes observed in this study suggest that this combined approach may lead to significant improvements in pelvic floor muscle function and patient-reported outcomes. The implications of this study extend to healthcare professionals involved in the management of postpartum pelvic floor dysfunction. The findings highlight the potential benefits of integrating real-time three-dimensional transperineal ultrasound and the magnetic and electrical repair approach into clinical practice. This combination could enhance treatment effectiveness, optimize patient outcomes, and contribute to evidence-based decision-making. Furthermore, the results of this study underscore the importance of further research in this field. While the findings are promising, additional studies are needed to validate the clinical significance, long-term effectiveness, and safety of this combined approach. Future research should include larger sample sizes, longer follow-up periods, and comparative studies with other treatment modalities to establish the optimal management strategies for postpartum pelvic floor dysfunction.

Limitations of this study should be acknowledged, and several areas warrant further investigation in future research. Firstly, the sample size of this study was relatively small, which limits the generalizability of the findings. Future studies with larger and more diverse populations would help validate the results and provide a more robust understanding of the effectiveness of the combined approach. Secondly, the follow-up period in this study was relatively short, and the long-term outcomes of the treatment were not assessed. Evaluating the sustainability of the improvements in pelvic floor muscle function and patient-reported outcomes over an extended period would provide valuable insights into the durability of the intervention. Additionally, this study focused on the clinical significance of using real-time three-dimensional transperineal ultrasound and the combined magnetic and electrical repair approach. However, further research is needed to investigate the underlying mechanisms of action. Understanding the specific physiological and neuromuscular changes induced by the intervention would enhance our knowledge of how these modalities contribute to the improvements observed. Furthermore, this study primarily assessed subjective outcomes based on patient-reported measures. Objective assessments, such as electromyography or objective measures of pelvic floor muscle strength, could provide additional insights into the treatment effects and further strengthen the study's findings. Future research should also explore the optimal treatment protocols and parameters for the combined approach. Investigating the dosage, frequency, and duration of magnetic and electrical stimulation, as well as the individualized tailoring of treatment based on real-time ultrasound findings, would help optimize the therapeutic interventions. Lastly, the safety profile of the combined approach should be thoroughly examined in future studies. Although no adverse events were reported in this study, a comprehensive assessment of potential risks and complications associated with the intervention is crucial for its clinical implementation.

CONCLUSION

This study demonstrates that the combination of real-time three-dimensional transperineal ultrasound and the magnetic and electrical repair approach shows promise as an effective therapeutic strategy for postpartum pelvic floor dysfunction. The integration of these modalities leads to significant improvements in pelvic floor muscle function and patient-reported outcomes compared to standard treatments. The use of real-time three-dimensional transperineal ultrasound allows for targeted treatment interventions by accurately assessing the structure and function of the pelvic floor muscles.

AUTHOR DISCLOSURE STATEMENT

The authors declare that they have no competing interests.

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