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THE EFFECTIVENESS OF FUNCTIONAL MAGNETIC STIMULATION FOR URINARY INCONTINENCE IN PATIENTS WITH DIABETIC NEUROPATHY

GADARA K¹, DESAI B^{2*} AND PATEL GJ³

- 1: Master in Physiotherapy Scholar, Department of Neurological conditions and Psychosomatic Disorders, Ahmedabad Physiotherapy College, Parul University, Gujarat, India
- 2: Associate Professor, Master in Neurology, Ahmedabad Physiotherapy College, Parul University, Gujarat, India; **Orchid Id: 0000-0003-0214-5900**
- 3: Principal, Master in Neuroscience, Ahmedabad Physiotherapy College, Parul University, Gujarat, India; **Orchid Id: 0000-0002-7741-1786**

***Corresponding Author: Ms. Binal Desai: E Mail: binal.desaiapc@paruluniversity.ac.in**

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ABSTRACT

Background: Urinary incontinence (UI) is a common and distressing complication in patients with diabetic neuropathy, significantly affecting quality of life. Conventional physiotherapy is widely used; however, nerve damage associated with diabetic neuropathy may limit its effectiveness. Functional magnetic stimulation (FMS) is a non-invasive modality that induces pelvic floor muscle contractions and may offer additional benefits in managing urinary incontinence.

Methods: An experimental study design was conducted with 30 patients diagnosed with diabetic neuropathy and urinary incontinence, randomly allocated into two groups (n = 15 each). Group A received functional magnetic stimulation combined with conventional physiotherapy, while Group B received conventional physiotherapy alone. Interventions were administered three sessions per week for six weeks. Outcome measures included the ICIQ-SF, ICIQ-LUTSqol, and the Saskatchewan Pelvic Floor Pathway. Pre- and post-intervention assessments were analyzed using non-parametric tests (Wilcoxon signed-rank test and Mann–Whitney U test)

Results: Both groups showed statistically significant improvement in all outcome measures following intervention ($p < 0.001$). However, post-treatment comparisons between groups revealed significantly greater improvement in the experimental group compared to the control group across all outcome

measures ($p < 0.001$). Baseline characteristics, including age and gender distribution, were comparable between groups, indicating homogeneity.

Conclusion: Functional magnetic stimulation combined with conventional physiotherapy is more effective than conventional physiotherapy alone in reducing urinary incontinence symptoms and improving quality of life in patients with diabetic neuropathy. FMS appears to be a safe, non-invasive, and effective adjunct treatment for managing urinary incontinence in this population.

Keywords: Diabetic neuropathy, urinary incontinence, functional magnetic stimulation, pelvic floor rehabilitation, physiotherapy

INTRODUCTION

Diabetes mellitus is a chronic metabolic disorder characterized by persistent elevation of blood glucose levels due to impaired insulin secretion, impaired insulin action, or both. Among its various types, type 2 diabetes mellitus (T2DM) is the most prevalent and accounts for nearly 90–95% of all diabetes cases worldwide. The increasing prevalence of T2DM has become a major public health concern, as prolonged poor glycemic control leads to several long-term complications that significantly affect functional ability and quality of life. One of the most common and disabling complications is diabetic neuropathy, which develops gradually as a result of chronic hyperglycemia, oxidative stress, and microvascular insufficiency affecting nerve tissues [1, 2].

Diabetic neuropathy may involve both peripheral and autonomic components of the nervous system. Autonomic neuropathy affecting the lower urinary tract can disrupt normal bladder sensation, detrusor muscle activity, urethral sphincter control, and

coordination of the pelvic floor muscles. As a result, individuals may experience a range of lower urinary tract symptoms, including urinary urgency, increased frequency, nocturia, hesitancy, incomplete bladder emptying, urinary retention, and various forms of urinary incontinence. These symptoms often progress insidiously and can significantly interfere with daily activities, social participation, emotional well-being, and overall quality of life [3, 4]. Pelvic floor muscles play a crucial role in maintaining urinary continence by supporting pelvic organs and assisting in urethral closure, particularly during increases in intra-abdominal pressure such as coughing, lifting, or physical exertion. In individuals with diabetic neuropathy, chronic metabolic changes and nerve damage can impair pelvic floor muscle strength, endurance, coordination, and sensory feedback. Although pelvic floor muscle training is widely recommended as a first-line conservative intervention for urinary incontinence, its effectiveness may

be limited in patients with diabetic neuropathy due to reduced muscle awareness, impaired neuromuscular transmission, and difficulty performing correct voluntary contractions [5-7].

Functional magnetic stimulation has emerged as a non-invasive and painless rehabilitation modality for pelvic floor muscle activation and management of urinary incontinence. This technique uses pulsed magnetic fields to stimulate sacral nerve roots, producing strong and consistent involuntary contractions of the pelvic floor muscles without the need for voluntary effort, surface electrodes, or internal probes. Functional magnetic stimulation is generally well tolerated and may be particularly beneficial for individuals with sensory or motor impairments, such as those with diabetic neuropathy. By enhancing pelvic floor muscle activation, neuromuscular coordination, and bladder control mechanisms, functional magnetic stimulation represents a promising therapeutic option. However, evidence specifically targeting individuals with diabetic neuropathy remains limited, highlighting the need for focused clinical investigation and inclusion of this modality within physiotherapy management protocols [6-8].

This may result in the improvement of detrusor inhibition, urethral closure pressure, and muscular coordination of the

muscles that are engaged in continence. These physiological effects make functional magnetic stimulation a promising approach to study for managing urinary incontinence, especially in patients with diabetic neuropathy [9, 10].

Therefore, this thesis needs to investigate effect of FMS for UI in patients with diabetic neuropathy, including both male and female participants, in order to provide clinically relevant data, fill existing gaps in the literature, and support evidence-based physiotherapy interventions for this growing patient population [11, 12].

Objective: To determine and compare the effectiveness of functional magnetic stimulation versus conventional physiotherapy on urinary incontinence symptoms and quality of life in patients with diabetic neuropathy.

MATERIALS AND METHODOLOGY

- Study design: Experimental study
- Source of data: Kadji Care Rehabilitation Center, Vadodara, Gujarat.
- Sample size: 15 in each group (30 subjects)
- Sampling method: Simple random
- Study duration: One year
- Study population: subjects with diabetic neuropathy
- Treatment duration: 3 sessions/week for 6 weeks

Inclusion Criteria:

- Age 40 to 60 years: diabetic neuropathy
- Both male and female participants
- Patient having a complaint of UI

Exclusion Criteria:

- Active UTI
- Malignancy (or oncological disease/cancer)
- Prior “pelvic floor surgery” (or previous “pelvic floor surgeries”)
- Implanted cardiac pacemaker (or heart stimulator/pacemaker)
- Any metallic implants (or metal implants/foreign bodies in the body)

OUTCOME MEASURE

ICIQ-SF—In a clinical context, this brief and user-friendly questionnaire evaluates amount of UI and its effect on QOL. The questionnaire's four items have an overall score 0 to 21, with more scores denoting more amount symptoms: 0 denotes no UI “symptoms”, 1–5 mild UI “symptoms”, 6–12 moderate UI “symptoms”, 13–18 severe UI “symptoms”, and 19–21 very severe UI “symptoms” [18].

ICIQ-QoL – It is a validated, condition-specific instrument utilized in both clinical and research settings to check effect of UI on health-related QOL. It consists 22 items covering domains such as physical limitations, social interactions, emotional well-being, role functioning, personal

relationships, sleep, and embarrassment.

Each item is numbered on 5-points, total score ranges from 22 - 110, with more numbers indicating more impairment in QOL due to urinary incontinence, while lower scores reflect minimal impact [19].

SASKATCHEWAN PELVIC FLOOR PATHWAY - Saskatchewan Pelvic Floor Pathway is a standardized clinical assessment tool used to evaluate pelvic floor muscle function. It assesses ability to voluntarily contract and relax PFM, endurance, repetition capacity, coordination with breathing, and functional activation during activities such as coughing or movement. Higher scores indicate better pelvic floor muscle function and coordination, while lower scores reflect higher impact [20].

STATISTICAL TOOLS

All data were systematically collected, tabulated using Microsoft Excel, and subsequently analyzed using SPSS software version 26. Continuous variables were expressed as mean $\pm$ standard deviation (SD), while categorical variables were presented as frequencies and percentages. A significance level of $p < 0.05$ was considered statistically significant for all analyses. The normality of data distribution for all outcome measures in both groups was assessed using the Shapiro–Wilk test, which revealed non-normal distribution; therefore, non-parametric statistical tests were applied.

Demographic variables such as age were compared between groups using the Mann–Whitney U test, while gender distribution was analyzed using the chi-square test, confirming comparable baseline characteristics between groups. Within-group comparisons of pre- and post-intervention outcome measures were performed using the Wilcoxon signed-rank

test to evaluate treatment effects over time. Between-group comparisons were conducted using the Mann–Whitney U test to determine differences between the experimental and control groups. Statistical significance was observed in post-intervention comparisons, indicating superior improvement in the experimental group compared to the control group.

Table 1: Age Distribution of Participants

Outcomes Measures	Experimental		Control		P-VALUE (between group)
	Mean	SD	Mean	SD	
Age	50.33	3.83	50.40	3.22	0.820

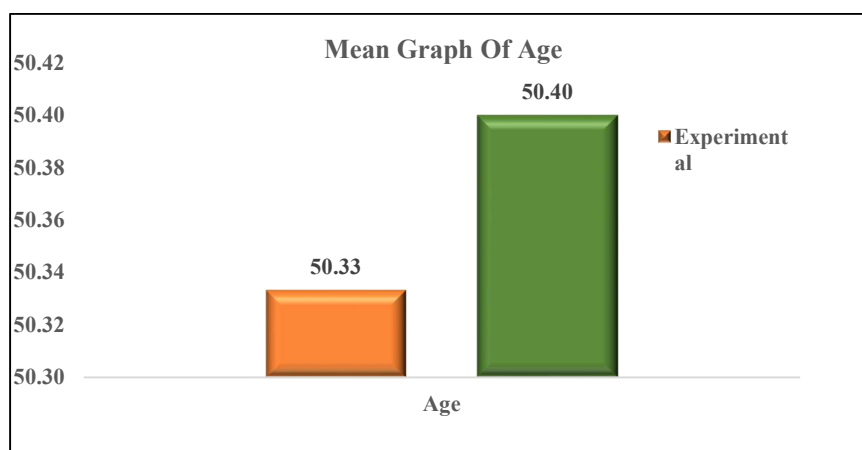


Figure 1

Table 2: Gender Distribution of Participants

Gender (Experimental)			Gender (Control)	
	N	Percent (%)	N	Percent (%)
FEMALE	13	86.7	13	86.7
MALE	2	13.3	2	13.3
Total	15	100.0	15	100.0

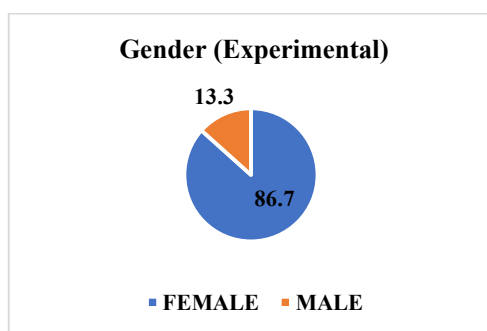


Figure 2

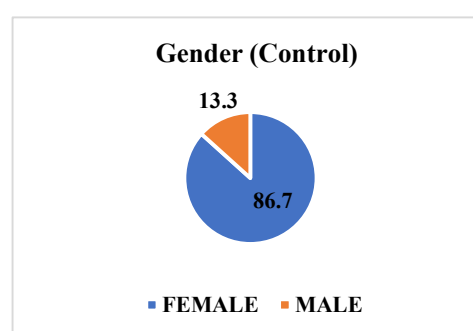


Figure 3

Table 3

Outcomes Measures	Experimental			Control			P-VALUE (between group)
	Mean	SD	P-VALUE	Mean	SD	P-VALUE	
Pre GRP ICIQ-SF	14.73	1.03	P<0.001	14.80	0.86	P<0.001	0.896
Post GRP ICIQ-SF	6.00	0.76		10.00	0.76		P<0.001
Pre GRP ICIQ-LUTSqol	53.47	1.64	P<0.001	53.33	1.45	P<0.001	0.816
Post GRP ICIQ-LUTSqol	34.00	0.76		44.00	0.76		P<0.001
Pre GRP Saskatchewan Pelvic Floor Pathway	6.87	0.74	P<0.001	6.60	0.63	P<0.001	0.317
Post GRP Saskatchewan Pelvic Floor Pathway	14.00	0.76		10.00	0.76		P<0.001

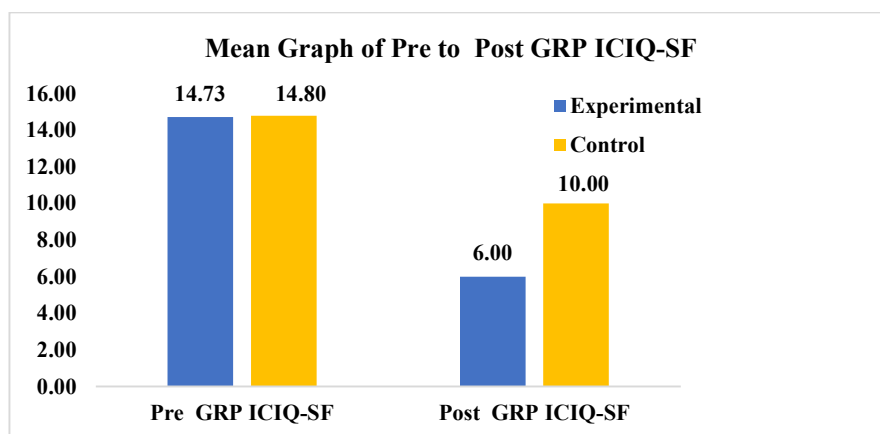


Figure 4

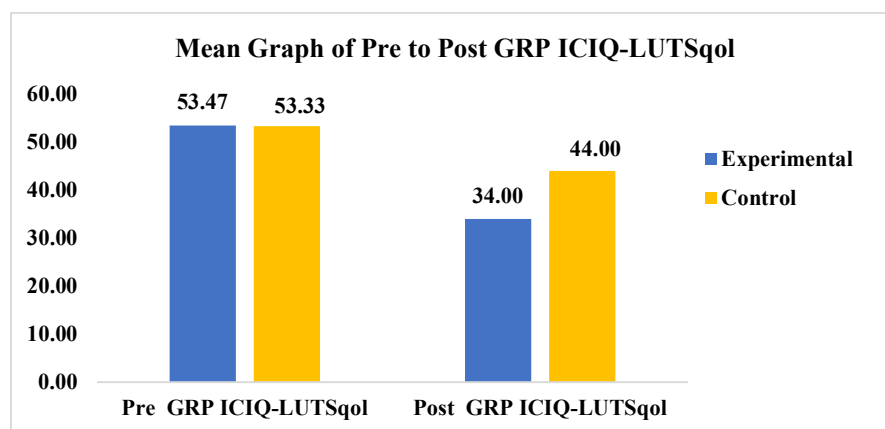


Figure 5

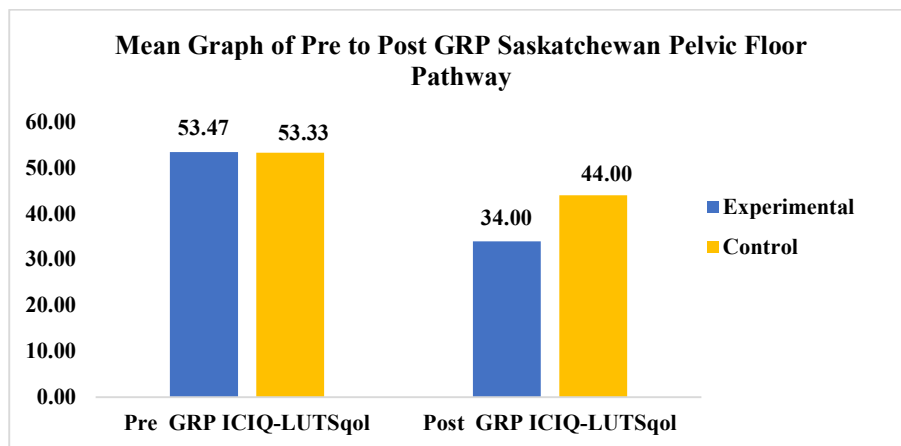


Figure 6

DISCUSSION

This study compared the effectiveness of Functional Magnetic Stimulation (FMS) with conventional physiotherapy in managing urinary incontinence (UI) among patients with diabetic neuropathy. Diabetic neuropathy progressively damages peripheral and autonomic nerves, leading to impaired bladder sensation, altered detrusor activity, poor urethral sphincter control, and weak pelvic floor coordination, all of which contribute to UI. The mean age of participants was around 50 years, consistent with the age range where diabetic complications and bladder dysfunction are common. The predominance of female participants reflects epidemiological data showing higher UI prevalence in women, influenced by anatomical differences, hormonal changes, pregnancy, childbirth, and menopause, which are further aggravated by diabetes-related neuropathy [3–7, 27, 28].

Both groups showed significant improvement after six weeks, but the FMS group demonstrated greater reductions in ICIQ-SF scores, urinary leakage frequency, and LUTSqol measures, indicating enhanced quality of life and emotional well-being. Improvements in pelvic floor pathway scores further suggest better muscle activation, endurance, and functional control. These superior outcomes can be attributed to the unique mechanism

of FMS, which uses pulsed magnetic fields to stimulate sacral nerve roots (S2–S4), producing involuntary and synchronized pelvic floor contractions. This bypasses impaired voluntary activation in neuropathy, thereby improving strength, coordination, and neuromuscular control [11–17, 22–25].

Previous studies support these findings, showing that FMS enhances urethral closure pressure, reduces detrusor overactivity, decreases leakage episodes, and strengthens pelvic floor muscles without adverse effects. In contrast, conventional physiotherapy also improved outcomes but less effectively, as it relies on patient effort, motivation, and voluntary muscle control. Post-intervention comparisons confirmed that FMS was significantly superior across all measures, leading to rejection of the null hypothesis and acceptance of the alternative hypothesis [13–17, 23–25].

Clinically, FMS offers several advantages: it is non-invasive, painless, does not require electrodes or skin contact, and is comfortable for patients, especially those with comorbidities or older age. Its electromagnetic induction penetrates clothing and tissues, stimulating sacral and pudendal nerves to produce supramaximal contractions, greater motor unit recruitment, and reflexive pelvic floor activation during sudden increases in intra-abdominal pressure. These effects improve urethral support, closure pressure, and bladder reflex

modulation, thereby reducing leakage. Unlike traditional physiotherapy, FMS delivers consistent contractions automatically, eliminating variability in treatment outcomes [13–15, 21, 26].

Overall, while both interventions are effective, the magnitude of improvement was consistently greater in the FMS group. These results confirm that FMS is not only therapeutic but superior to conventional physiotherapy, making it a safe, effective, and patient-friendly first-line conservative treatment for urinary incontinence in diabetic neuropathy [3–5, 13–17, 21, 26–28].

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