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A CASE REPORT ON EFFECT OF PULSED ELECTROMAGNETIC FIELD THERAPY ON AN INDIVIDUAL DIAGNOSED WITH DIABETES MELLITUS TYPE 2 ALONG WITH A NARRATIVE LITERATURE REVIEW

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Abstract

Introduction

Diabetes Mellitus Type 2 (DM2) is a leading health issue globally. This research article demonstrates a case report of a diagnosed case of a 45 year old male participant with DM2 along with a narrative literature review on the effect of pulsed electromagnetic field (PEMF) therapy in individuals diagnosed with DM2.

Materials and methodology

A detailed case report was undertaken to evaluate the efficacy of a 15 Hz amplitude PEMF therapy impulse on Fasting Blood Glucose (FBS) and HbA_1c (%). Along with PEMF therapy; a structured therapeutic exercise regimen under supervision was followed. A reduction in the blood glucose parameters was noted. An extensive narrative literature review was carried out to understand the reasons for the reduction of blood glucose levels in individuals diagnosed with DM2.

Results

Seven research articles were critically analyzed which found favourable results towards the addition of PEMF therapy in the management of individuals diagnosed with DM2. The main outcome of interest was reviewing the effect of pulsed electromagnetic field therapy in diabetes mellitus and its related complications. Thus, after the application of the eligibility criteria, studies were analyzed based on aim of the study, duration/ follow up, intervention protocol, outcome measures or parameters assessed, and most significant results. In addition, the description of the PEMF devices used in the various studies for the treatment of diabetes mellitus type 2 and its related conditions was also analyzed, along with the additional information reported of the device used.

Discussion

The reduction in the blood glucose levels in this case report could be attributed towards an increase in synthesis of nitric oxide as result of administration of PEMF therapy as explained in the narrative literature review.

Conclusion

The addition of PEMF therapy could have potentially more beneficial effects in the management of increased blood glucose levels among individuals diagnosed with DM2.

Key words: Pulsed Electromagnetic Field Therapy, Diabetes Mellitus Type 2, Blood Glucose Levels

Introduction

Diabetes Mellitus Type 2 (DM2) has become a leading health issue in developing countries like India. [1, 2]Approximately, 69 million people in India are diagnosed with DM2. [3] Management of DM2 involves pharmaceutical and non- pharmaceutical approaches like diet and physiotherapy. [4, 5]

Pulsed electromagnetic field (PEMF) therapy is an advanced electrotherapy modality used currently by physiotherapists worldwide. It is an invisible and non-invasive therapy which is administered by influencing an individual either generally or locally with a magnetic field packed in impulse bundles of frequency ranges between 0.25 and 50 Hz. The electrical energy is used to conduct a series of magnetic impulses through the particular body tissue. This leads to each magnetic impulse inducing tiny electrical signals which stimulate and provide a virtual message for each particular cell. Mitochondrion also known as the powerhouse of the cell absorbs PEMF therapy waves, which activates a series of reactions to increase and store more cellular energy in the form of adenosine triphosphate. Thus, stimulating the biological function of cells, tissues and body systems within an individual resulting in raising the overall vital energy of the individual. [6, 7, 8]

Following are the physiological effects of PEMF therapy: a. Enhance capillary formation; b. Accelerate nerve regeneration; c. Enhance synthesis of proteins; d. Increase permeability of cells; e. Increase availability of nitric oxide; f. Increase removal of waste products. [6, 7, 8]

It is evident that serum nitric oxide (NO) has emerged as a fundamental signal associated with the endothelial dysfunction in diabetes mellitus type 2. [9] PEMF therapy promotes angiogenesis, and release of nitric oxide in individuals diagnosed with diabetes mellitus type 2. [10] Therefore, PEMF therapy could be able to have a therapeutic effect on DM2 and its related conditions. Moreover, when PEMF therapy is added to a standard therapy protocol, it seems to hardly add any harmful effect in DM2 and its related conditions. [11] However, due to the low risk associated, PEMF therapy can be a potential alternative or adjunct to pharmacological therapy. The lack of studies in this theme warrants further research on PEMF effects on DM2. Hence, we have opted to conduct a case study along with a narrative review of literature.

CASE REPORT

A 45 year old male diagnosed with DM 2 since 7 years who is on normal glucose lowering pharmacotherapy was recruited for this case report from the out-patient physiotherapy department. The pre-intervention Fasting Blood Glucose (FBS) levels of 218 mg/dL and HbA_1c of 11.7%. A 15 Hz PEMF therapy impulse of amplitude[12] was administered for 12 weeks excluding Sundays for a total of 72 therapy sessions for 30 minutes per day. Along with PEMF therapy, supervised therapeutic exercises were performed for 12 weeks. The participant was re-assessed after 4 weeks, 8 weeks and post – intervention after 12 weeks. The FBS at 4 weeks was 181 mg/dL, at 8 weeks was 149 mg/dL and 123 mg/dl at the end of the intervention. The HbA_1c at 4 weeks was 9.8%, at 8 weeks was 7.9% and 6.4% at post – intervention. Contra – indication to PEMF therapy and therapeutic exercises were taken into account before initiating the intervention for the diabetic participant. The therapeutic exercise regimen was as given in table 1, table 2, table 3, table 4 and table 5.[13, 14]

Therapeutic Exercise Programme: To be followed for 3 days per week on alternate days for 12 weeks

Table 1: Therapeutic Exercise Programme [13, 14]

Day	**Exercise Type**
Monday	Aerobic Exercise
Tuesday	Free Exercises
Wednesday	Aerobic Exercise
Thursday	Free Exercises
Friday	Aerobic Exercise
Saturday	Free Exercises

Warm Up: General range of motion exercises for all peripheral joints.

Aerobic Exercises

Each activity in the sequence will be repeated 8 times and each sequence will be performed for 3 sets.

Table 2:

Week wise sequence of aerobic exercises[8]

Sequence 1	Sequence 2	Sequence 3	Sequence 4	Sequence 5	Sequence 6
Spot Walking	Spot Walking	Spot Walking	Spot Walking	Spot Walking	Step Up Up Down Down
Tap Outs	Side Step	Wide squat throw ball forward	Medicine ball diagonal pattern down to up	Mini Squat	Step Knee down down
Spot Walking	Spot Walking	Spot Walking	Spot Walking	Spot Walking	Step Up Up Down Down
Skater - Tap behind foot	Knee up	Wide squat throw ball diagonally upwards	Medicine ball diagonal pattern up to down	Mini Squat Punch forward with alternate hands	Step Ham Curl down down
Spot Walking	Spot Walking	Spot Walking	Spot Walking	Spot Walking	Step Up Up Down Down
Side Steps	Knee Up with hand rotation to same side	Wide squat throw ball diagonally downwards	Medicine ball chest throw	Mini Squat Punch Upward with alternate hands	Step leg back down down
Spot Walking	Spot Walking	Spot Walking	Spot Walking	Spot Walking	Step Up Up Down Down

'V' Walks	Kick forward	Wide squat throw ball upward	Oblique‟s-Side to Side	Punch downward with alternate hands	Step kick forward down down
Spot Walking	Spot Walking	Spot Walking	Spot Walking	Spot Walking	Step Up Up Down Down
High Knees	Kick forward with arms outstretched	Wide squat throw ball sideways	Triceps Throw	Punch Sideways alternately in each direction	Step leg sideways down down
Spot Walking	Spot Walking	Spot Walking	Spot Walking	Spot Walking	Step Up Up Down Down
Kick Forward	Knee Up with Pull down	Wide squat bounce ball on ground	Biceps Throw	Punch Sideways Up with alternate hands	
Spot Walking	Spot Walking	Spot Walking	Spot Walking	Spot Walking	
Knee Curls	Squat			Punch Sideways Down with alternate hands	
Spot Walking	Spot Walking			Spot Walking	
				Punch Sideways Behind with alternate hands	
				Spot Walking	

Table 3: Free Exercises for the core muscles to be performed every Tuesday for 12 weeks[8]

Sr. No.	Exercise	Hold	Rest
1	Pelvic Bridging	8 seconds	3 seconds
2	Supine Straight Leg Raise	8 seconds	3 seconds
3	Quadripod - Raise 1 upper	8 seconds	3 seconds

	extremity alternatively		
4	Quadripod - Raise 1 lower extremity	8 seconds	3 seconds
5	Bird Dog	8 seconds	3 seconds
6	Modified Crunches	8seconds	3 seconds

Table 4: Upper extremity resisted exercises to be performed on every Thursday and lower extremity resisted exercises to be performed on every Saturday for 12 weeks.[8]

Sr. No.	Exercise	Hold	Rest
Upper Extremity			
1	Shoulder Flexion to 90 degree	8 seconds	3 seconds
2	Shoulder Abduction to 90 degree	8 seconds	3 seconds
3	Bicep Curls	8 seconds	3 seconds
4	Tricep Curls	8 seconds	3 seconds
5	Wrist Curls- Flexion	8 seconds	3 seconds
6	Wrist Curls - Extension	8 seconds	3 seconds
Lower Extremity			
7	Dynamic Quadriceps	8 seconds	3 seconds
8	Hip Flexion above 90 degree in sitting	8 seconds	3 seconds
9	Side Lying Straight Leg Raise	8 seconds	3 seconds
10	Hamstring Curls	8 seconds	3 seconds
11	Heel Raises	8 seconds	3 seconds
12	Toe Raise	8 seconds	3 seconds

Table 5: Progression of Free exercises week wise is as follows:-[8]

Week	Repetitions
1 - 3	5
4-6	8
7-9	10
10-12	12

Cool Down: Followed with a cool down period 5 minutes of Savasana.[13, 14]

The novel unique structured therapeutic exercises were performed at a moderate intensity of 12 – 13 on the Rate of Perceived Exertion (RPE) Scale.[13, 14, 15] The participant was regularly asked while performing the therapeutic exercises about the perceived exercise intensity as per the Rate of Perceived Exertion (RPE) Scale. [13, 14, 16] A set guidelines for precautions, safety and termination criteria of therapeutic exercise session were followed. [13, 14, 15]

Considerable reduction in blood glucose levels was noted. This reduction in blood glucose levels could be attributed to greater glucose uptake by the muscles and increase in release of nitric oxide.

NARRATIVE LITERATURE REVIEW

A comprehensive database search was conducted using PubMed, Scopus, Cochrane Library, MedLine, PEDro, Google Scholar and also searched for any available relevant studies in grey literature that assessed the efficacy of the PEMF therapy on diabetes mellitus and its related complications. The search was performed by using the following key words **"'Pulsed Electromagnetic Field Therapy' And ('Diabetes Mellitus' Or 'its related complications')".** The reference lists of most relevant studies were scanned for studies to be included in the narrative literature review. Bias was avoided as two different authors are reviewing the articles independently and wherever a question of dispute arose a third author intervened. All research articles till 25th April, 2024, were included in the search. Two independent investigators (PP and TP) conducted the search. Wherever a disagreement arose, it was settled by the intervention of a third author (FS) to resolve the dispute. All disagreements were resolved after a consensus was reached between the three authors. Therefore, bias was aptly avoided, as two author reviewers were involved, and if required, a third author reviewer also intervened whenever necessary.

STUDY SELECTION

All relevant research article titles and abstracts were screened from the relevant databases. After retrieving the potentially relevant studies, full texts were read to apply the eligibility according to the following inclusion criteria: (1) Use of pulsed electromagnetic field therapy, (2) Prospective Study Design, (3) English language, (4) Diabetes Mellitus or its related complications, (5) Published / Black Literature, (6) Unpublished / Grey Literature. Exclusion criteria was determined by (1) Animal studies, (2) Complete study not available, (3) Associated with other ailments, (4) PEMF therapy applied along with surgical intervention, (5) Pregnant females[17]

DATA COLLECTION AND EXTRACTION

Two independent investigators (PP and TP) retrieved all the information and matched for consensus. The main outcome of interest was reviewing the effect of pulsed electromagnetic field therapy in diabetes mellitus and its related complications. Thus, after the application of the eligibility criteria, studies were analyzed based on aim of the study, duration/ follow up, intervention protocol, outcome measures or parameters assessed, and most significant results. In addition, the description of the PEMF devices used in the various studies for the treatment of DM2 and its related conditions was also analyzed, along with the additional information reported of the device used.

RESULTS

STUDY SELECTION

A total of 97 articles were initially selected through database searching based on title and abstract. Only seven research articles were found to be relevant to the search strategy incorporated which were analyzed in detail. The exclusion of articles from the narrative literature review was mainly due to the full text being not available; surgical procedure used to apply PEMF; duplicates of research article; research articles in non-English language or other languages, or it was associated with other physical ailments along with diabetes mellitus type

2 and other related conditions. A total of 90 articles were excluded from the narrative literature review. Finally, only seven articles were selected in the narrative literature review.

DESCRIPTION OF STUDIES

Table one presents the characteristics of the seven included original research studies. Overall, the studies included a total of 219 participants. All the included participants reported complaints of either DM2 or its related conditions; however, with different aetiologies like: DM2 and DM2 complications like diabetic polyneuropathy or neuropathy, peripheral blood circulation and diabetic foot ulcers. [18 - 25]

The inclusion criteria varied across all the research articles included in the narrative literature review. Nonetheless, across the included research articles, a few similarities were found among the research articles. All the research studies were done in an adult population above 18 years of age, with clinically evaluated DM2 and its related conditions. Pregnancy or planned pregnancy and presence of cardiac pacemaker or other electronic implants was a common exclusion criterion among most of the included studies reviewed. The other exclusion criteria were study specific exclusion criteria in the respective research articles.

Table 6 shows one review, six randomised controlled trials and one pre- post design included in this narrative review. The best level of evidence was 1b for six articles and 2b for the pre-post design study.

Table 6: Characteristics and main results of the included research articles

References	**Type of Study**	**Aim**	**Duration / Follow-Up**	**Intervention Protocol**	**Parameters Assessed**	**Results**
Graak V. et al[18]	Randomised Controlled Trial	To evaluate and compare the effect of low power, low frequency pulsed electromagnetic field of 600 and 800 Hz respectively in management of patients with diabetic	12 days	N= 30 Group 1 (n1=10) – 600 Hz; Group 2 (n2=10) – 800 Hz; Control Group (n3=10)	• Neuropathy; - Pain - Motor Nerve Conduction parameters (distal latency, amplitude, nerve conduction velocity	• Significant reduction in pain and statistically significant improvement in distal latency and nerve conduction

		polyneuropathy				velocity • PEMF can modulate neuropathic pain and nerve impulse due to decrease in endoneural hypoxia, perineural edema, ischemia of peripheral nerves and improved microcirculation • Limitation: Small sample size, Short duration of treatment, non-

						availability of follow-up data
Sun J. et al[19]	Randomised Controlled Trial	To study whether PEMFs would increase blood flow velocity of the smallest observable vein in people with or without Diabetes Mellitus	One time intervention	N= 43 Group 1 (n1=22) – Diabetes Mellitus; Group 2 (n2=21) – Healthy participants	• Blood circulation - Blood flow velocity and diameter of the small vein by ultrasound biomicroscopy - Microcirculation at skin over base of 1st metatarsal bone and distal 1st phalanx measured by laser Doppler flowmetry	• PEMF increases peripheral blood flow but not general microcirculation in individuals with or without DM
Wrobel M. et al[20]	Randomised, placebo controlled, double blinded	To assess whether a low frequency magnetic field can influence pain intensity, quality of life and sleep , and glycemic control in	3 weeks, 20 min a day, 5 days a week	N= 61 Group 1 (n1=32) – low frequency magnetic field Group 2 (n2=29) – sham exposure	• Pain - (SFMPQ-VAS) • Sleep – MOS Sleep Scale • Quality of Life (EuroQoL EQ-5D At the beginning and after one, two, three and five weeks	• Significant reduction in pain intensity • Extent of pain reduction did not differ signific

		patients with painful diabetic polyneuropathy			• HbA1c - - at baseline and after 5 weeks	antly between the groups • Both groups had similar improvements in in EuroQoL, MOS and HbA1c values
Sharon T[21]	Grey literature – Pilot Study	To provide an evidentiary basis for using PEMF therapy in a primary care setting to promote microvascular angiogenesis and thereby prevent skin ulceration	10 – 22 treatments with a Diapulse PEMF device	N= 7; individuals between 54 to 65 who have diabetes mellitus type 2 and some level of Diabetic lower extremity ischemia (DLEI)	A laser Doppler flowmeter was used to assess • Microvascular red blood cell (RBC) perfusion • Volume concentration of moving RBCs • RBC speed • Temperature In the Plantar skin	• Significant improvement in microvascular red blood cell perfusion, volume concentration of moving RBCs (V), RBC speed (U) and temperature (T) in

						the plantar skin, Inclusion of PEMF for treating chronic wounds should be considered
Battecha K. et al[22]	Controlled trial	To investigate the effect of Pulsed Electromagnetic Field on pain and nerve conduction velocity in patients with diabetic peripheral neuropathy	3 times per week for 4 weeks	N= 30; individuals between 40 to 50 who have diabetic neuropathy of both sexes Group A (n=15) PEMF Frequency = 50 Hz, Intensity =20G; Group B (n=15) – Traditional Physical	• Pain – Visual Analogue Scale • Peroneal Nerve Conduction velocity by computerized electromyography	• Significant reduction of pain intensity by visual analogue scale and significant improvement of peroneal nerve conduction velocity in PEMF group • It could be concluded that PEMF combined with traditional physica

						l therapy program has a positive effect on diabetic neuropathy symptoms
Padma K.et al[23]	Pre-Post Study	To evaluate the efficacy of pulsed electromagnetic field therapy as an adjunct therapy in diabetic foot ulcers	45 mins / day for 30 days	N= 30; Diabetes 7.8±1.47 years; mean duration of foot ulcer 4.9±1.2 months with Wagner's grade 1 and 2 were subjected for PEMF therapy	• Wound Surface Area	• Significant reduction in wound surface area observed could be due to PEMF that helped in healing of tissues, improved circulation and reduced inflammation • Thus, PEMF can be an effectiv

						e and safe adjuvant therapy for treating diabetic foot ulcers
Tallis A. et al[24]	Randomised, Sham-Controlled, Double Blind Pilot Study	To determine the potential efficacy of and safety of dual energy pulsed electromagnetic field therapy (PEMF) on painful distal symmetric diabetic sensorimotor polyneuropathy (DSPN)	Twice daily for 30 mins for 60 days	N= 18 PEMF – n=11, Sham n=7 subjects with Type 2 Diabetes and painful DSPN	• Objective Measures 1. Skin biopsy 2. NCV study 3. Plantar foot skin perfusion pressure • Patient reported outcomes 1. Perception of pain 2. Concomitant medication use 3. Adverse events	• Improved Dorsal foot Skin perfusion Pressure, Improved velocity, conduction and amplitude of plantar and sural nerve, compliance with device use was noted along with no long term use

						adverse effects • Limitation: Need for large sample size research studies in order to generalize findings

Table 7shows the PEDro score rating of each of the research articles included in the narrative review. The worst PEDro score was for a study with a score of 3. The best PEDro score was 8 for four of the research articles in the narrative review.

Table 7 shows the PEDro scale rating for each of the research articles included in the study

References	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**Total**
Graak V. et al[18]	+	+	-	+	-	-	-	+	+	+	+	7
Sun J. et al[19]	+	+	-	+	-	-	-	+	+	+	+	7
Wrobel M. et al[20]	+	+	+	+	-	-	-	+	+	+	+	8
Sharon T[21]	+	+	-	+	-	-	-	+	+	+	+	7
Battecha K. et al[22]	+	+	+	+	-	-	-	+	+	+	+	8
Padma K.et al[23]	+	-	-	-	-	-	-	+	-	-	+	3
Tallis A. et al[24]	+	+	+	+	-	-	-	+	+	+	+	8

Seven experimental design studies were included in the narrative literature review. The PEMF therapy was often compared with sham treatment or pharmacotherapy or other electrotherapy modality or exercise therapy regimen. Moreover, the studies showed heterogeneity concerning the PEMF therapy protocols, where the duration of application varied from 12 days to 60 days, and the frequency of application from twice a day for 60 days to a single time intervention. [9, 11-17]

The parameters assessed included Wound healing (Wound Surface Area); Neuropathy; Blood Glucose Control (HbA_1c); Blood Flow (Blood flow velocity and diameter of the small vein by ultrasound biomicroscopy, Microcirculation at skin over base of first metatarsal bone and distal first phalanx, Microvascular red blood cell (RBC) perfusion, Volume concentration of moving RBCs, RBC speed, Temperature in the Plantar skin measured by laser Doppler flowmetry); Inflammation; Oxidative Stress; Motor Nerve Conduction Velocity (distal latency, amplitude, nerve conduction velocity); Pain - (SFMPQ-VAS); Sleep – MOS Sleep Scale; Quality of Life (EuroQoL EQ-5D); Skin Biopsy; Patient reported outcomes (Perception of pain, Concomitant medication use, Adverse events). [18 – 24]

DISCUSSION

The main finding of this narrative literature review is that PEMF therapy seems to have a therapeutic effect in DM2 and its related conditions. PEMF therapy has found to be effective in the management of DM2 and its related conditions. It has found to be a safe and reliable tool for the treatment of DM2 and its related conditions.

The findings from the research articles included in the narrative literature review was that PEMF therapy has a positive attributes towards wound healing, chronic pain and neuropathy.[18 - 24]

PEMF was caused a reduction in pain and statistically significant improvement in distal latency and nerve conduction velocity. [19, 21] PEMF could modulate neuropathic pain and nerve impulse due to decrease in endoneural hypoxia, perineural edema, ischemia of peripheral nerves and improved microcirculation.[19,] A significant improvement in microvascular red blood cell perfusion, volume concentration of moving RBCs (V), RBC speed (U) and temperature (T) in the plantar skin.[20] It was also found to reduce the wound surface area.[23]

It is commonly found in individuals with DM2, a reduced synthesis of Nitric Oxide which happens to be a key underlying pathophysiology in DM2. [18] PEMF therapy plays a very important role in boosting the synthesis of Nitric oxide in the human body. Therefore, the key mechanism of action for the efficacy of PEMF therapy in individuals with DM2 is that PEMF helps in the synthesis of Nitric Oxide which helps in normalizing the diseased state in DM2. Also, PEMF therapy enhances capillary formation; accelerates nerve regeneration; enhances synthesis of proteins; increases permeability of cells; and increases removal of waste products. Thus, aids in the treatment of DM2 and its related complications.

Similarly, Palekar P. et al and Palekar T. et al in two separate studies have mentioned the possible mechanism of action of PEMF therapy in individuals diagnosed with DM2 resulting in an increase in synthesis of nitric oxide which is substantially reduced in individuals diagnosed with DM2.[25, 26, 27] Therefore, PEMF therapy can be included in the management of DM2 and its related conditions as an alternative or as an adjunct to pharmacotherapy. But, there is a need for more extensive research to be carried out to study the effects of PEMF therapy in

individuals with DM2 and its related conditions. More case series, clinical trials and systematic reviews ought to be conducted to study the efficacy of PEMF therapy in individuals with DM2 to create more evidence based practice.

CONCLUSION

The evidence within this case report and narrative literature review demonstrates that the PEMF therapy seems to be able to have a therapeutic effect on DM2 and its related conditions. Moreover, when PEMF therapy is added to a standard therapy protocol, it seems to hardly add any harmful effect in DM2 and its related conditions. However, due to the low risk associated, PEMF therapy can be a potential alternative or adjunct to pharmacological therapy. The lack of studies in this theme warrants further research on PEMF effects on DM2 and its related conditions, with standardized protocols, larger samples, and adjustment for DM2 and its related conditions confounders to achieve stronger conclusions.

REFERENCES

1. Lin Y., Sun Z.; Current views on type 2 diabetes; Journal of Endocrinology; 2010; Volume 204; Pg. 1 – 11.

2. Vijayakumar G., Vijayakumar R., Simon L., Scaria L., Kutty V., Jaleel A., et al.; Incidence of type 2 diabetes mellitus and prediabetes in Kerela, India: results from a 10-year prospective cohort; BMC Public Health; 2019; Volume 19

3. Unnikrishnan R., Anjana R., Mohan V.; Diabetes mellitus and its complications in India; Nature Reviews Endocrinology; 2016; Volume 12; Pg. 357 – 370.

4. Chawla R., Krishnan D., Saboo B., Jaggi S., Makkar B., Baruah M., et al.; Insights on Medical Nutrition Therapy for Type 2 Diabetes Mellitus: An Indian Perspective; Advances in Therapy; 2019; Volume 36; Issue 3; Pg. 520 – 547.

5. Brunneti L., Kalabalik J.; Management of Type – 2 Diabetes Mellitus in Adults; Pharmacy and Therapeutics; 2012; Volume 37; Issue 12; Pg. 687 – 696.

6. Palekar T., Gonsalves N.; A Narrative Literature Review On Effect Of Pulsed Electromagnetic Field Therapy In Diabetes Mellitus Type 2 And It's Possible Mechanism Of Action; Journal of Critical Reviews; 2020; Volume 7; Issue 15.

7. Amwaves Wellness; Pulsed Electromagnetic Therapy Brochure

8. Dorotka R., Vavken P., Arrich F., Schuhfried O.; Effectiveness of Pulsed Electromagnetic Field Therapy in the Management of Osteoarthritis of the Knee: a Meta-Analysis of Randomized Controlled Trials; Journal of Rehabilitation Medicine; 2009; Volume 41; Issue 6; Pg. 406 – 409.

9. Choi H., Cheing A., Ng G., Cheing G.; Effects of pulsed electromagnetic field (PEMF) on the tensile biomechanical properties of diabetic wounds at different phases of healing; PLoS One; 2018; Volume 13; Issue 1.
10. Palekar T., Gonsalves N.; Effect of Pulsed Electromagnetic Field Therapy in Cervical and Lumbosacral Spine-Related Pain: A Systematic Review; Medical Journal of Dr. D.Y. Patil Vidyapeeth; 2023.
11. Palekar T., Gonsalves N.; A narrative literature review on effect of pulsed electromagnetic field therapy in diabetes mellitus type 2 and it's possible mechanism of action; Journal of Critical Reviews; 2020; Volume 7; Issue 15
12. Ayad P., Aziz A., Mohamed A., Shendy M.; Effect of Pulsed Magnetic Field Therapy Versus Aerobic Training on Peripheral Arteries in Type 2 Diabetes; Medical Journal of Cairo University; December, 2020; Volume 88; Issue 5.
13. Palekar T., Rawat A., Goel N., Shaikh F., Wanjara N.; A proposed pre test – post test design for a therapeutic exercise program for rehabilitation of individuals suffering from diabetes mellitus type 2; International Journal of Research and Analytical Reviews (IJRAR); March 2024; Volume 11; Issue 1
14. Rawat A., Palekar T., Vig B., Wanjara N., Shaikh F.; Effect of a novel structured therapeutic exercise program on blood glucose levels in individuals suffering from diabetes mellitus type 2; Journal of Emerging Technologies and Innovative Research (JETIR); April, 2024; Volume 11; Issue 4
15. Flairty J., Scheadler C.; Perceived and Heart-Rate based intensities during Self-paced Walking: Magnitudes and Comparisons; International Journal of Exercise Sciences; 2020; Volume 13; Issue 5; Pg. 677 – 688
16. Day M., McGuigan M., Brice G., Foster C.; Monitoring Exercise Intensity During Resistance Training Using The Session RPE Sclae; Journal of Strength and Conditioning Research; 2004; Volume 18; Issue 2; Pg 353-358
17. Weintraub M., Herrmann D., Smith A., Backonja M., Cole S.; Pulsed electromagnetic fields to reduce diabetic neuropathic pain and stimulate neuronal repair : a randomized controlled trial; Archives of Physical Medicine and Rehabilitation; 2009; Volume 90; Issue 7; Pg. 1102 -1109.

18. Graak V., Chaudhary S., Bal B., Sandhu J.; Evaluation of the efficacy of pulsed electromagnetic field in the management of patients with diabetic polyneuropathy; International Journal of Diabetes in Developing Countries; 2009; Volume 29; Issue 2; Pg. 56–61
19. Sun J., Kwan R[1], Zheng Y, Cheing G.; Effects of pulsed electromagnetic fields on peripheral blood circulation in people with diabetes: A randomized controlled trial; Bioelectromagnetics; 2016; Volume 37; Issue 5; Pg. 290-297.

20.Wrobel M., Strojek K., Wystrychowski G., Biniszkiewicz T., Sieroń-Stołtny K., Sieroń A. et al.; Impact of low frequency pulsed magnetic fields on pain intensity, quality of life and sleep disturbances in patients with painful diabetic polyneuropathy; Diabetes and Metabolism, 2008; Volume 34; Pg. 349-354.

21. Sharon T.; An investigation of the Effects of Pulsed Electromagnetic Field Therapy on Plantar Skin Blood Perfusion in People with Diabetes Mellitus Type 2: A Pilot Study, Brandman University, 2015; Grey Literature (Unpublished literature)

22. Battecha K.; Efficacy of Pulsed Electromagnetic field on pain and nerve conduction in patients with diabetic neuropathy, bulletin of Faculty of Physical Therapy, 2017; Volume 22; Pg. 9-14

23. Amareswari V., Padma K., Dharmarajan P., Shivakumar S. , Dhilip K.; Evaluation of Efficacy of Pulsed Electromagnetic Field Therapy as an Adjuvant Therapy in Healing of Diabetic Foot Ulcers; International Journal of Physiology, 2020; Volume 8; Issue 2.

24. Tallis A., Jacoby R., Muhlenfeld J., Smith A.; A Randomized, Sham-Controlled, Double-Blind Pilot Study of Pulsed Electromagnetic Field Therapy to Evaluate Small Fiber Nerve Growth and Function and Skin Perfusion in Subjects with Painful Peripheral Diabetic Neuropathy; Journal of Diabetic Complications & Medicine; 2017; Volume 2; Issue 2; Pg. 117 – 122

25. Palekar P., Baxi G., Palekar T., Wanjara N., Singh G., Vishal B.; Systematic Review on Effect of Pulsed Electromagnetic Field Therapy on wound surface area in diabetic foot ulcers; Journal of Chemical Health Risks; 2023; Volume 13; Issue 4

26. Palekar T., Gonsalves N.; Does the addition of Pulsed Electromagnetic Field therapy to therapeutic exercises in physiotherapy management improve blood glucose levels in individuals with Diabetes Mellitus Type 2? A study protocol for a randomised controlled trial; European Journal of Molecular and Clinical Medicine; 2020; Volume 7; Issue 10

27. Tessari P., Cecchet D., Cosma A., Vettore M., Coracina A., Avogaro A.et al.; Nitric Oxide Synthesis Is Reduced in Subjects With Type 2 Diabetes and Nephropathy; Diabetes; 2010; Volume 59; Issue 9, Pg. 2152–2159.