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Analysing the Effects of Longwave Diathermy on Quality of Life among Patients with Knee Osteoarthritis: A Pilot Study

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ABSTRACT

Introduction: Knee Osteoarthritis (OA) is a chronic degenerative condition that significantly impairs the Quality of Life (QoL) in individuals over the age of 50 years. Longwave Diathermy (LWD), known for its ability to improve circulation, reduce pain and enhance functional recovery, has emerged as a promising physiotherapeutic intervention.

Aim: To evaluate and compare the effects of Pulsed Longwave Diathermy (PLWD) and Continuous Longwave Diathermy (CLWD) on QoL in individuals with knee OA, assessed across all domains of the World Health Organisation Quality of Life Brief version (WHOQoL-BREF): physical health, psychological health, social relationships and environmental health.

Materials and Methods: A comparative pilot study was conducted in the Outpatient Department, Department of Physiotherapy, Amity Institute of Health Allied Sciences, Amity University, Noida, Uttar Pradesh, India, from January 2023 to May 2023. Study included 30 participants aged ≥45 years, diagnosed with grade 2-3 knee OA (Kellgren-Lawrence scale). Participants were randomly assigned to two groups: grade 1 received PLWD with conventional therapy and grade 2 received CLWD with conventional therapy for eight weeks, three times per week. The WHOQoL-BREF was employed as the primary outcome measure to evaluate QoL across four domains: psychological, social, physical and environmental well-being. Assessments using the WHOQoL-BREF were conducted at three key time points: baseline (prior to intervention), after four weeks of intervention and after eight weeks of intervention. Mann-Whitney U test was employed to compare baseline characteristics and differences between the two groups. Analysis of Variance (ANOVA) was used for significant interactions between time points and groups.

Results: Both groups showed significant improvements in QoL across all WHOQoL-BREF domains. However, the CLWD group demonstrated greater improvements compared to the PLWD group. In the physical health domain, mean±Standard Deviation (SD) scores improved from 31.33±0.49 at baseline to 56.13±1.85 at eight weeks (F=2.575, p-value<0.05). For psychological health, mean±SD scores increased from 24±5.86 to 54±0 (F=2.575, p-value<0.05). Social relationships mean±SD scores rose from 39.33±10.77 to 68±0 (F=3.533, p-value<0.05). Lastly, the environmental health domain improved from 31.33±0.49 to 56.33±1.76 (F=17.92, p-value<0.05).

Conclusion: The CLWD, when combined with conventional therapy, significantly enhances QoL in individuals with knee OA across all domains of the WHOQoL-BREF. These findings highlight its potential as an effective non invasive intervention for managing knee OA. Further large-scale studies are recommended to confirm these results and explore individualised treatment protocols.

Keywords: Environmental health, Physical health, Psychological health, Social relationships

INTRODUCTION

The OA is one of the most prevalent degenerative joint disorders globally, affecting millions of individuals and posing a significant burden on health systems. Characterised by the progressive degradation of articular cartilage, the formation of osteophytes and inflammation of the synovium, knee OA leads to chronic pain, functional limitations and diminished QoL [1,2]. The disease's multifactorial aetiology includes aging, obesity, joint injuries and genetic predisposition, making it a complex condition to manage effectively [3]. Despite its high prevalence, knee OA remains a challenging condition for healthcare professionals, requiring multimodal therapeutic approaches to address both structural and symptomatic impairments.

Knee OA significantly impacts QoL across multiple domains, including physical, psychological and social well-being. Physical limitations, such as reduced mobility and chronic pain, often lead to depression, anxiety and social isolation. Moreover, the economic burden of medical care and productivity loss further exacerbates the condition's impact on patients' lives [4]. Comprehensive QoL assessments, such as the WHOQoL-BREF, have become instrumental in evaluating the broader implications of therapeutic interventions beyond just pain and function [5]. This multidimensional approach underscores the need for evidence-based interventions that not only alleviate symptoms but also restore overall well-being.

Physiotherapy has long been a cornerstone in the conservative management of knee OA. Interventions such as structured exercise programmes, manual therapy and electrotherapy modalities aim to reduce pain, improve function and enhance overall QoL [6]. Among these, LWD has gained increasing attention for its ability to provide both thermal and non thermal benefits to patients with musculoskeletal disorders. LWD is a promising modality that operates at frequencies between 0.3 MHz and 1 MHz, delivering electromagnetic waves capable of penetrating deeper tissues [7]. By targeting the affected areas, LWD can alleviate inflammation, enhance blood circulation and modulate pain, making it an effective adjunct in the management of knee OA [8].

The therapeutic effects of LWD can be attributed to its unique mechanism of action, which involves both thermal and non thermal pathways. The thermal effects of LWD include vasodilation, improved metabolic activity and enhanced tissue repair, while its non thermal effects modulate inflammatory responses and nerve conduction. These mechanisms are particularly effective in reducing pain and stiffness associated with knee OA [9,10]. Importantly, LWD can be administered in two modes: pulsed and continuous. The pulsed mode minimises tissue heating while promoting metabolic activity, whereas the continuous mode induces sustained thermal effects that facilitate deeper tissue repair [11]. These distinct features make LWD a versatile option for addressing the diverse needs of knee OA patients.

Numerous studies have explored the applications of LWD in various conditions. For instance, a study conducted in 2017 highlighted the effectiveness of LWD in significantly reducing pain among patients with chronic pain conditions, demonstrating its potential to improve functional outcomes [12]. Additionally, research from 2020 indicated that LWD plays a vital role in reducing inflammation and accelerating recovery in athletes experiencing Delayed-onset Muscle Soreness (DOMS), underscoring its benefits in tissue recovery [13]. Another study found that combining LWD with myofascial release improved pain and muscle relaxation in patients with upper trapezius spasms [14]. A 2019 study demonstrated that LWD effectively alleviated symptoms of Chemotherapy-induced Peripheral Neuropathy (CIPN). The findings highlighted improvements in nerve conductivity and a significant reduction in inflammation [15]. These studies collectively underscore the versatility and efficacy of LWD across a range of musculoskeletal and systemic conditions.

Despite these promising findings, research on the use of LWD specifically for knee OA remains limited. Most studies have focused on pain relief and functional improvements without adequately addressing the broader impact on QoL [6]. Furthermore, comparative studies evaluating the efficacy of pulsed vs continuous modes of LWD in knee OA are scarce. These gaps in the literature highlight the need for rigorous research to establish standardised protocols and optimise treatment outcomes [16-18].

The present study was aimed to evaluate and compare the effects of pulsed and continuous LWD on the QoL of individuals with knee OA. By using the WHOQoL-BREF assessment tool, the present study sought to provide a comprehensive understanding of how LWD influences physical, psychological, social and environmental domains. The findings from the current study will contribute to the growing body of evidence supporting LWD as a viable intervention for knee OA, addressing both symptomatic relief and holistic well-being.

Therefore the aim of the present study was to determine the efficacy of pulsed and continuous LWD in improving QoL among individuals with knee OA. Specifically, the study sought to identify the domains of QoL most affected by LWD therapy and compare the therapeutic effects of its pulsed and continuous modes. The present research which was underpinned by the following hypotheses:

Null Hypotheses (H_0): There is no significant difference in the improvement of overall QoL between the PLWD group and the CLWD group when combined with conventional physiotherapy.

Alternate Hypotheses (H_1): CLWD combined with conventional physiotherapy results in greater improvement in overall QoL than PLWD combined with conventional physiotherapy.

MATERIALS AND METHODS

The present comparative pilot study was conducted in the Outpatient Department, Department of Physiotherapy, Amity Institute of Health Allied Sciences, Amity University, Noida, Uttar Pradesh, India, from January 2023 to May 2023. Ethical approval was granted by the Amity Institute of Health Allied Sciences Institutional Review Board (AUUP/IEC/JUN/2022/5) and the trial was registered with India's Clinical Trial Registry (CTRI/2023/05/052912). Written informed consent was obtained from all participants prior to enrollment.

Sample size calculation: A total of 30 participants diagnosed with grade 2 or 3 knee OA, based on the Kellgren-Lawrence classification, were recruited for this pilot study [19,20]. The sample size was determined by referencing similar studies that utilised 30 participants to assess the efficacy of LWD in pain management and functional improvement [6,18]. Participants were randomised into two groups using the envelope method to ensure allocation concealment:

Group 1 (PLWD): PLWD combined with conventional therapy;

Group 2 (CLWD): CLWD combined with conventional therapy.

Inclusion and Exclusion criteria: To ensure a homogenous study population, specific inclusion and exclusion criteria were applied based on prior studies [19,20]. Participants were eligible for inclusion if they were 45 years or older and diagnosed with unilateral or bilateral knee OA classified as grade 2 or 3 according to the Kellgren-Lawrence classification. Additionally, participants should not have engaged in regular physiotherapy or leg exercises for at least six months. Conversely, individuals were excluded if they had a history of knee surgery or major trauma, exhibited hip or ankle instability, severe weakness (manual muscle testing <3), or significant joint laxity. Those who had received intra-articular injections within four weeks prior to the study, had unresolved neurological or balance disorders, or conditions affecting gait or lower-limb function were also excluded. Furthermore, participants with psychosis or depression requiring opioid injections, or those who had undergone knee or hip replacement surgery, were not considered eligible for the study [19,20].

Study Procedure

Intervention Protocol: Preparation of the patient

Participants were positioned in a comfortable supine position with the affected knee exposed and undressed. Any jewellery or cosmetics in the treatment area were removed to prevent interference with the diathermy equipment. The active electrode was moved in circular motions over the affected knee joint and the inactive electrode was held by the patient in the contralateral hand.

Group 1 (PLWD and conventional therapy): The PLWD was delivered at a frequency of 1 MHz in a 1:1 pulsed mode. The active electrode was moved in circular motions over the affected knee during the 10-minute session, which was applied three times per week for eight weeks [6].

Group 2 (CLWD and conventional therapy): The CLWD was delivered at a frequency of 1 MHz, applied continuously for 10 minutes per session, three times per week for eight weeks.

The active electrode was moved in circular motions over the affected knee, with the inactive electrode placed on the contralateral hand. Both groups received conventional therapy as part of the intervention protocol [21]. This included ultrasound therapy administered for six minutes per session, three times a week and the application of a hydrocollator hot pack for 10 minutes, three times a week. Additionally, participants performed quadriceps isometric exercises and hamstring stretching exercises, with each comprising one set of ten repetitions, three times a week [21].

The comprehensive therapy protocol was administered over eight weeks to ensure consistency and evaluate long-term effects. This standardised approach allowed for direct comparisons between the therapeutic efficacy of PLWD and CLWD.

Outcome measure: The outcome measure was QoL, assessed using the WHOQoL-BREF questionnaire. This validated tool consists of 26 items and evaluates QoL across four domains:

Physical health: Assesses pain, mobility and energy levels.

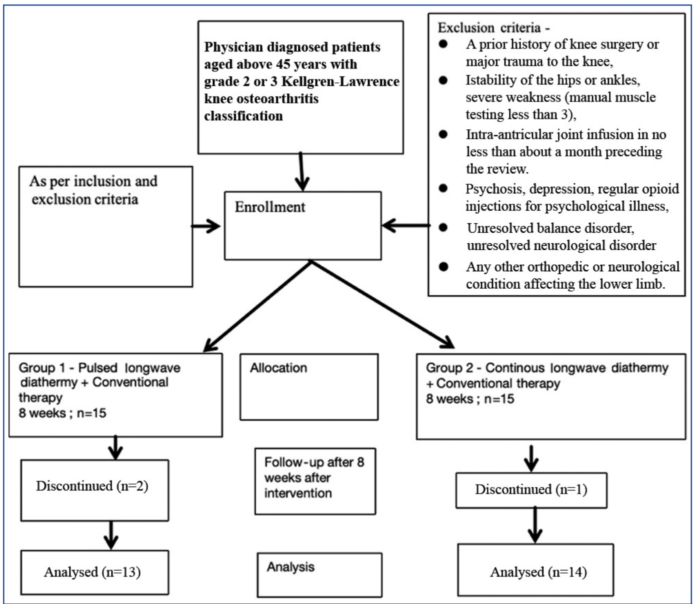
Psychological health: Evaluates emotional well-being and cognitive functioning.

Social relationships: Examines interpersonal relationships and social support.

Environmental health: Assesses living conditions and access to healthcare.

Each domain is scored on a Likert scale (1 to 5) and the raw scores are transformed into a 0-100 scale, with higher scores indicating better QoL [4]. The WHOQoL-BREF assessments were conducted at baseline, four weeks and eight weeks.

The study followed the Consolidated Standards of Reporting Trials (CONSORT) guidelines, as depicted in the flowchart [Table/Fig-1]. Participants who met the inclusion and exclusion criteria were randomised into two groups. Among the 30 enrolled participants, 13 in Group 1 and 14 in Group 2 completed the study. The flowchart highlights the recruitment, allocation, intervention and analysis stages, ensuring transparency and adherence to methodological rigor.



[Table/Fig-1]: Flowchart illustrating the CONSORT guidelines.

This comprehensive methodology ensured the reliability of the results and adherence to ethical standards while evaluating the comparative efficacy of PLWD and CLWD in improving QoL in Knee OA patients.

STATISTICAL ANALYSIS

The statistical analysis for the present study was conducted using International Business Machines (IBM) Statistical Package for the Social Sciences (SPSS) software 20.0 statistics for the Mann-Whitney U test. This non parametric test was employed to compare baseline characteristics and differences between the two groups (PLWD vs CLWD) for non normally distributed variables. Results were reported as medians and interquartile ranges and significance was tested with a p-value≤0.05. The test also provided a 95% confidence interval to estimate the range within which the true population parameter lies. A repeated measures ANOVA was used to evaluate within-group and between-group differences across the three time points: baseline, four weeks and eight weeks. The dependent variable was the domain-specific scores of WHOQoL-BREF and the independent variable was the treatment group (PLWD or CLWD). ANOVA was specifically chosen to identify significant interactions between time (baseline, four weeks, eight weeks) and group (PLWD vs CLWD), highlighting the temporal effect of the interventions.

RESULTS

A total of 30 participants diagnosed with unilateral or bilateral knee OA (grade 2 or 3 based on the Kellgren-Lawrence classification) were included in the study. Participants were evenly divided into two groups, with 15 participants in each group: the PLWD group and the CLWD group. The baseline demographic characteristics were assessed and no significant differences were found between the two groups, ensuring comparability [Table/Fig-2].

The mean±SD age of participants in the PLWD group was 65.26±3.12 years, while the CLWD group had a mean±SD age of 65.66±2.63 years (p-value=0.53). Height measurements revealed a mean±SD value of 146.46±4.79 cm for the PLWD group and 147.53±3.75 cm for the CLWD group (p-value=0.37). Mean±SD weight was recorded as 75.13±3.398 kg in the PLWD group and 74.86±3.62 kg in the CLWD group (p-value=0.81). Both groups displayed a balanced gender distribution, with nine females and six males in the PLWD group, compared to eight females and seven males in the CLWD group. Additionally, the distribution of unilateral and bilateral knee OA was nearly equal, with the PLWD group comprising eight unilateral and seven bilateral cases and the CLWD group consisting of seven unilateral and eight bilateral cases.

Variables	PLWD group (n=15) (Mean±SD/n)	CLWD group (n=15) (Mean±SD/n)	p-value
Age (years)	65.26±3.12	65.66±2.63	0.53
Height (cm)	146.46±4.79	147.53±3.75	0.37
Weight (kg)	75.13±3.398	74.86±3.62	0.81
Gender (Female/Male)	9/6	8/7	-
Unilateral/bilateral OA	8/7	7/8	-

[Table/Fig-2]: Baseline demographic characteristics of participants.

Statistical analyses of baseline characteristics were conducted using the Mann-Whitney U-test, which is appropriate for non normally distributed data. The test confirmed no statistically significant differences between the groups for age, height, weight, or gender (all p-value>0.05). Additionally, an F-ratio was calculated to assess the variability between the groups, further supporting the homogeneity of the baseline demographic characteristics.

These findings establish that the groups were well-matched at baseline, ensuring that any observed differences in treatment outcomes could be attributed to the intervention rather than demographic variability.

WHOQoL-BREF psychological domain: The psychological domain of the WHOQoL-BREF assesses emotional well-being, cognitive functioning and self-esteem. In the present study, significant improvements were observed in the psychological well-being of participants in both the PLWD and CLWD groups over time, with the CLWD group demonstrating greater overall improvement. At baseline, the mean±SD psychological scores were 20±1.46 for the PLWD group and 24±5.86 for the CLWD group. After four weeks, the mean±SD scores increased to 29.67±0.98 for the PLWD group and 36.33±5.09 for the CLWD group. By the end of eight weeks, the mean±SD scores reached 45.33±4.65 for the PLWD group and 54±0.00 for the CLWD group. These findings, represented in [Table/Fig-3], illustrate the mean and standard deviation values across the three timepoints (baseline, four weeks and eight weeks) for both groups.

Statistical analysis using repeated measures ANOVA revealed significant improvements in psychological scores over time and

Domain	Timepoint	PLWD group (Mean±SD)	CLWD group (Mean±SD)
Psychological	Preintervention	20.00±1.46	24.00±5.86
Psychological	Postintervention (4 weeks)	29.67±0.98	36.33±5.09
Psychological	Postintervention (8 weeks)	45.33±4.65	54.00±0.00
Social	Preintervention	34.67±5.43	39.33±10.77
Social	Postintervention (4 weeks)	47.67±4.17	49.33±6.67
Social	Postintervention (8 weeks)	61.80±3.90	68.00±0.00
Physical	Preintervention	31.33±0.49	31.33±0.49
Physical	Postintervention (4 weeks)	36.27±0.46	36.40±0.51
Physical	Postintervention (8 weeks)	50.13±3.85	56.13±1.85
Environmental	Preintervention	31.27±0.47	31.47±0.51
Environmental	Postintervention (4 weeks)	36.60±0.40	36.67±0.45
Environmental	Postintervention (8 weeks)	50.47±3.38	56.33±3.35

[Table/Fig-3]: Comparison of mean and standard deviation of WHOQoL-BREF scores across psychological, social, physical and environmental domains for PLWD, as well as, CLWD interventions at baseline, four weeks and eight weeks.

between groups. The F-ratio for the time factor was 281.675, with a p-value<0.05, confirming substantial improvements over the 8-week period. The group effect yielded an F-ratio of 92.450, with a p-value<0.05, indicating significant differences in psychological improvement between the PLWD and CLWD groups. Additionally, the interaction of time × group was significant, with an F-ratio of 2.575 and a p-value<0.05, suggesting that the two groups responded differently to the interventions over time. These statistical findings are visualised in [Table/Fig-4], which presents the repeated measures ANOVA results.

Domain	Factor	F-Ratio	p-value
Psychological	Time	281.675	≤0.001
	Group	92.45	≤0.001
	Time × group	2.575	0.039
Social	Time	106.358	≤0.001
	Group	6.049	0.002
	Time × group	3.533	0.043
Physical	Time	281.675	≤0.001
	Group	92.45	≤0.001
	Time × group	2.575	0.039
Environmental	Time	36.402	≤0.001
	Group	717.755	≤0.001
	Time × group	17.92	0.004

[Table/Fig-4]: Repeated measures ANOVA results for psychological, social, physical and environmental domains of WHOQoL-BREF across time and groups in knee OA patients treated with PLWD and CLWD.

The variable 'time' refers to the assessment periods—baseline, four weeks and eight weeks, while 'group' refers to the two intervention types: PLWD and CLWD. The progressive improvement in psychological scores for both groups, with the CLWD group consistently showing higher scores has been demonstrated in [Table/Fig-3]. The statistical significance of the effects of time, group and their interaction on psychological outcomes has been demonstrated in [Table/Fig-4]. These results highlight the efficacy of CLWD in enhancing psychological health in patients with knee OA, as reflected in the WHOQoL-BREF psychological domain.

WHOQoL-BREF social domain: The social domain of the WHOQoL-BREF assesses interpersonal relationships, social support and personal interactions. Both the PLWD and CLWD groups demonstrated significant improvements in social well-being over the course of the study. At baseline, the mean scores were 34.67±5.43 for the PLWD group and 39.33±10.77 for the CLWD group. After four weeks, the scores improved to 47.67±4.17 and 49.33±6.67, respectively. At the end of eight weeks, the scores further increased to 61.80±3.90 for the PLWD group and 68.00±0.00 for the CLWD group. These results are shown in [Table/Fig-3].

Repeated measures ANOVA revealed significant effects of time (F=106.358, p-value ≤0.001), group (F=6.049, p-value=0.002) and the time × group interaction (F=3.533, p-value=0.043). The factor of time indicates consistent improvement over the three assessment points (baseline, four weeks and eight weeks), while the group effect highlights greater efficacy in the CLWD group. The interaction effect further underscores that the improvements varied between the groups over time, favoring CLWD. These results are shown in [Table/Fig-4].

WHOQoL-BREF physical domain: The physical domain assesses aspects like pain, mobility and energy levels. Significant improvements were observed in both groups, with the CLWD group achieving better outcomes. At baseline, the mean±SD scores were 31.33±0.49 for the PLWD group and 31.33±0.49 for the CLWD group. After four weeks, the mean±SD scores increased to 36.27±0.64 for the PLWD group and 36.40±0.51 for the CLWD group. At eight weeks, the mean±SD scores further improved to 50.00±3.38 and 56.33±3.39, respectively. These results are detailed in [Table/Fig-3].

Repeated measures ANOVA revealed significant effects of time (F=281.675, p-value≤0.001), group (F=92.45, p-value≤0.001), and the time × group interaction (F=2.575, p-value=0.039). These results highlight the progressive and substantial improvement in physical well-being over the eight-week intervention period, with the CLWD group consistently outperforming the PLWD group. These results are shown in [Table/Fig-4].

WHOQoL-BREF environmental domain: The environmental domain evaluates living conditions, access to resources and feelings of safety. Both groups reported significant improvements, with the CLWD group showing greater enhancement. At baseline, the mean scores were 31.33±0.49 for the PLWD group and 31.33±0.49 for the CLWD group. After four weeks, the scores improved to 36.27±0.64 and 36.40±0.51, respectively. By eight weeks, the scores increased to 50.00±3.38 for the PLWD group and 56.33±3.39 for the CLWD group. These findings are represented in [Table/Fig-3].

Repeated measures ANOVA indicated significant effects of time (F=36.402, p-value=0.0001), group (F=717.755, p-value=0.0001), and the time × group interaction (F=17.92, p-value=0.004). The CLWD group exhibited consistently higher scores across all time points, demonstrating its superiority in enhancing environmental well-being. These results are shown in [Table/Fig-4].

DISCUSSION

The aim of the present study was to evaluate the efficacy of PLWD and CLWD in improving the QoL among individuals with knee OA. The results demonstrated that both interventions were effective in enhancing QoL, with CLWD showing greater efficacy across all domains of the WHOQoL-BREF, including psychological, social, physical and environmental dimensions. Notably, the present study represents a novel exploration of the impact of LWD on QoL, as previous research has primarily focused on pain relief and functional improvement.

Several studies have investigated the application of LWD in various musculoskeletal conditions, but none have specifically addressed its effect on QoL. One study demonstrated significant pain relief using LWD in musculoskeletal disorders, attributing its efficacy to deep tissue penetration and improved circulation [6]. Additionally, another study highlighted the benefits of LWD in DOMS, noting enhanced recovery and functional mobility [7]. Similarly, one study found that LWD effectively managed upper trapezius spasms, emphasising its potential as an adjunctive therapy in physiotherapy protocols [8]. Another study extended these findings to CIPN, showcasing LWD's utility in alleviating pain and discomfort [9]. These studies underscore the versatility of LWD in addressing pain and inflammation across diverse clinical contexts. However, the current research fills a critical gap by focusing on QoL outcomes, providing a broader perspective on the benefits of LWD in knee OA management.

Beyond LWD, other interventions have been explored for managing knee OA. Exercise therapy has consistently demonstrated efficacy in reducing pain and improving function, with studies by Bricca A et al., showing significant reductions in inflammatory biomarkers such as Interleukin-6 (IL-6) and Tumour Necrosis Factor-alpha (TNF-α) [10]. Vassão PG et al., highlighted the benefits of photobiomodulation combined with exercise, emphasising its role in enhancing QoL and reducing inflammation [11]. Fernandez-Cuadros ME et al., reported similar findings with ozone therapy, which improved both pain and QoL in knee OA patients [12].

While these modalities offer valuable benefits, they often focus on specific outcomes such as pain or inflammation. The integration of LWD with conventional physiotherapy, as demonstrated in the present study, provides a more holistic approach by addressing multiple QoL domains simultaneously.

The superior efficacy of CLWD can be attributed to its sustained thermal effects, which promote tissue oxygenation, reduce inflammation and enhance blood flow. These effects are particularly beneficial for chronic conditions like knee OA, where stiffness and pain significantly impair mobility and QoL. The non thermal effects of LWD, such as increased cellular permeability and protein synthesis, further amplify its therapeutic benefits [6,9]. By delivering continuous energy, CLWD facilitates deeper tissue penetration and prolonged therapeutic effects, which may explain its enhanced outcomes compared to PLWD.

The findings of the current study have significant clinical implications. First, they highlight the potential of CLWD as a cornerstone modality in physiotherapy for knee OA, offering superior outcomes in QoL compared to PLWD. Second, the integration of LWD with conventional therapies, including ultrasound, hot packs and exercise therapy, enhances its therapeutic efficacy. These results align with existing evidence supporting multimodal approaches in knee OA management, as demonstrated by Aguiar GC et al., and Fernandez-Cuadros ME et al., [12,14].

Furthermore, the present study provides a foundation for developing standardised treatment protocols for LWD in knee OA, focusing on optimal frequency, intensity and duration. By addressing both symptomatic and functional aspects of the disease, LWD offers a comprehensive solution for improving patient outcomes. To build on the findings of the present study, future research should include:

- Larger RCTs with diverse populations to enhance the external validity of the results.
- Studies with extended follow-up periods to evaluate the sustained impact of LWD on QoL and disease progression.
- Investigations into the comparative efficacy of LWD against other physiotherapy interventions such as shortwave diathermy, Transcutaneous Electrical Nerve Stimulation (TENS) and IFT.
- The establishment of standardised treatment guidelines for LWD, including optimal parameters for frequency, intensity and duration, which is crucial for its clinical adoption.

Limitation(s)

The small sample size limits the generalisability of the results. Larger, multicentre trials are needed to validate these findings. The eight-week intervention period does not capture long-term outcomes, necessitating studies with extended follow-up durations. While QoL was comprehensively evaluated, the absence of detailed pain and ROM measurements limits the clinical applicability of the findings. Variability in baseline characteristics, such as age and disease severity, may have influenced the outcomes. Stratified analyses in future research could address this issue.

CONCLUSION(S)

The present study demonstrates that both PLWD and CLWD are effective in improving QoL among individuals with knee OA, with CLWD showing superior outcomes across all domains. By addressing a critical gap in the literature and focusing on QoL as a primary outcome, the present research provides valuable insights into the potential of LWD as a holistic intervention for knee OA. The findings underscore the need for further research to optimise LWD protocols and expand their clinical applications, ultimately improving the lives of patients with this debilitating condition.

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