Original Article

Effectiveness of Low-Level Laser Therapy and Pulsed Ultrasound Combined with Exercise for Osteoarthritis of Knee

Dimple G U[1], Jagatheesan Alagesan[2], Buvanesh A[3]

[1]Undergraduate, [2]Professor, [3]Tutor, Saveetha College of Physiotherapy, Saveetha Institute of Medical and Technical Sciences, Chennai, Tamil Nadu, India.

How to cite this article: Dimple G U, Jagatheesan Alagesan, Buvanesh A. Effectiveness of Low-Level Laser Therapy and Pulsed Ultrasound Combined with Exercise for Osteoarthritis of Knee. Indian Journal of Physiotherapy and Occupational Therapy / Volume 18, Year 2024.

Abstract

Background: A slow loss of cartilage, pain, functional impairment, and a decreased quality of life are all characteristics of the degenerative inflammatory sickness- osteoarthritis of the knee, which affects the whole joint. Pulsed ultrasound primarily has properties to boost tissue metabolism, improve the extensibility of tissues that are fibrous, and raise pain thresholds. Laser beams having a wavelength of between 600 and 800 nanometers are produced by limited laser treatment. It stimulates regeneration and the release of beta-endorphins by increasing protein synthesis in synovial fluid.

Purpose: To find the effectiveness of Low Level Laser Therapy and Pulsed Ultrasound combined with exercise for osteoarthritis of knee.

Materials and Methods: Total of 60 participants were selected from ACIAN Ortho clinic. According to inclusion and exclusion criteria, the participants were explained about the treatment safety and written consent was obtained. The participating subjects were divided into two groups, Low Level Laser Therapy with exercise group and Pulsed Ultrasound with exercise group. All the subjects underwent pretest measurement with ROM and WOMAC at the beginning of the treatment. Study period : November 2022 to April 2023.

Results: Statistical analysis of data showed significant differences not only in the Ultrasound group but also in Low Level Laser Therapy. The Low Level Laser Therapy Group were significantly higher than the Pulsed Ultrasound group, with a p value of <0.0001

Conclusion: Low Level Laser Therapy is more effective than Pulsed Ultrasound for osteoarthritis of knee.

Key Words: Osteoarthritis of knee, Pulsed Ultrasound, Low Level Laser Therapy, Western Ontario and McMaster Universities Osteoarthritis Index, Range of motion, Isometric exercise.

Introduction

The degenerative inflammation illness osteoarthritis of the knee, which involves the entire joint, is defined by a gradual deterioration of cartilage along with discomfort, impairment, and a reduced quality of life. The commonest joint ailment is osteoarthritis, which primarily impacts joints that bear weight, like knees[1,2]. Osteoarthritis knee is due to mitochondrial malfunction, a state of oxidative stress, and poor chondrocyte response to

Corresponding Author: Jagatheesan Alagesan, Professor and Principal, Saveetha College of Physiotherapy, Saveetha Institute of Medical and Technical Sciences, Chennai, Tamil Nadu, India.

E-Mail: jagatheesanphd@gmail.com

developing stimuli. The knee's pathogenesis is the imbalance between chondrocytes' proliferation and differentiation[3,4,5].

Laser treatment has a wide range of biological impacts in alleviating pain linked with persistent osteoarthritis[6]. In Laser therapy, individual cartilage is stimulated to repair itself using a monochrome light beam without thermal stress[7]. Limited laser therapy, which generates laser beams with wavelengths between 600 and 800 nanometer, is frequently utilized to treat knee pain. As a result of influencing cutaneous nerve terminals, it mostly has analgesic effects, cellular activation and also causes responsive vasodilation. By stimulating protein synthesis in synovial fluid, it promotes regeneration and releases beta-endorphin, having an analgesic and anti-inflammatory action[8].

Pulsed ultrasound primarily has non-thermal properties to boost tissue metabolism, improve the extensibility of tissues that are fibrous, and raise pain thresholds[9]. A signal of electricity that is then transformed into a mechanical pressure wave by passing via a piezoelectric crystal. The crystal vibrates and emits sound waves, these waves pass through biological material, with some waves being reflected back towards the transducer[10]. Pulsed ultrasonic waves induce cells to vibrate longitudinally and can increase tissue healing by promoting the regulation of cell permeation, production of proteins, and osmotic exchange[11].

Aim

The aim of the study is to find the effectiveness of Low Level Laser Therapy and Pulsed Ultrasound combined with exercise for osteoarthritis of the knee.

Materials and Methods

A 60-person experimental investigation was carried out using Osteoarthritis of knee, age between 40-60 years was selected from ACIAN Ortho Clinic. A convenient sampling method was used in the study. Study period : November 2022 to April 2023.

Inclusion criteria

- Subjects with age of 40 to 60
- Both male and female were included
- Subjects with unilateral osteoarthritis knee
- Pain or stiffness over the knee

Exclusion criteria

- Subjects who are not interested in this study
- Subjects with recent history of surgery
- Rheumatoid Arthritis
- Subjects with recent history of trauma
- Neurological deficits
- Subjects who were currently using intra-articular corticosteroids
- Severe obesity (body mass index [BMI] > 40).

Outcome Measures

Assessments were done at the beginning (before the commencement of therapy) and Two weeks later.

- Range of motion(ROM)
- Western Ontario and McMaster universities Osteoarthritis Index (WOMAC)

Procedure

The inclusion and exclusion criteria resulted in the selection of a total of sixty individuals. After explaining the treatment's safety and ease of use to the individuals, a signed agreement was acquired. Participants who agreed to participate were split into two groups. Pulsed ultrasound combined with an exercise group and limited levels laser treatment. All subjects underwent pretest measurement with Range of motion and Western Ontario and McMaster Universities Osteoarthritis Index in the beginning of treatment.

Low-Level Laser Therapy Group:

An emission wavelength of 850 nm, power of 100mW was given for a duration of 5 minutes in length. Individuals lie in a supine position with their knees extended. The points that were irradiated were the medial and lateral epicondyle of the tibia and femur. The patient was instructed to perform 5 minutes of treatment in total each day. This was divided into 1 minute each at 5 different spots along the joint line and patellar ligament.

1. Medial anterior joint line
2. Lateral anterior joint line
3. Medial posterior joint line

4. Lateral posterior joint line
5. Proximal attachment of the patellar ligament

Pulsed Ultrasound Group:

The identical ultrasound machine was configured with a pulsed mode duty cycle frequency of 1 MHz, and a power of 2 W/cm^2. The Individual lie in a supine position and an acoustic gel that contained no pharmaceutically active material, was applied to the affected area. To ensure maximum energy absorption, ultrasound was then applied in circular motion to the medial and lateral aspects of the knee, that probe angled correctly. Pulsed ultrasound given for 5 minutes each session.

Exercise:

1. Quadriceps isometric exercise:

Individuals are lying supine. Under the knee, a towel was folded up. They were told to tense their quadriceps muscles as hard as they could for five seconds so as to straighten their knees.

2. Straight leg raising (SLR) exercise:

Individuals were advised to initiate a maximal isometric quadriceps contraction before the lifting portion of the exercise, elevate the leg up to 10 cm above the plinth, and maintain the contraction throughout the lifting phase for five seconds.

3. Long-arc quad exercise:

Individual is said to sit in a chair then straighten the affected leg, without locking your knee. Hold the leg out straight while counting till five.

4. Sit To Stand:

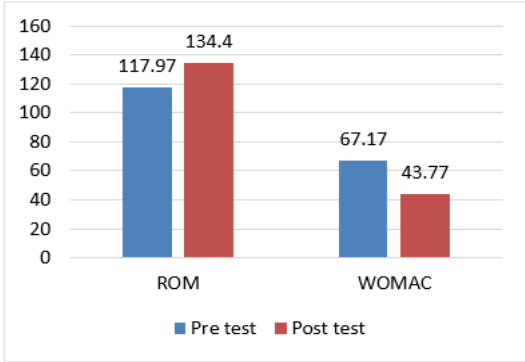
Sit tall in the front of the chair then stand up putting equal weight through the legs. Make sure to fully extend the knee and the hip. Then sit down reaching the chair. It is done in 3 sets of 10 repetitions.

5. Pillow Squeeze:

Individuals lie in supine position, both knees bent. Place a pillow between the knees. Squeeze the knees together, by squeezing the pillow between them. Hold for five seconds and relax. Two sets of 10 repetitions.

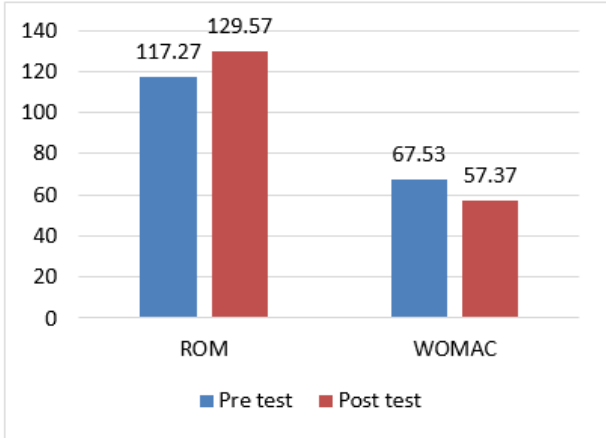
Data Analysis

Low Level Laser Therapy group:



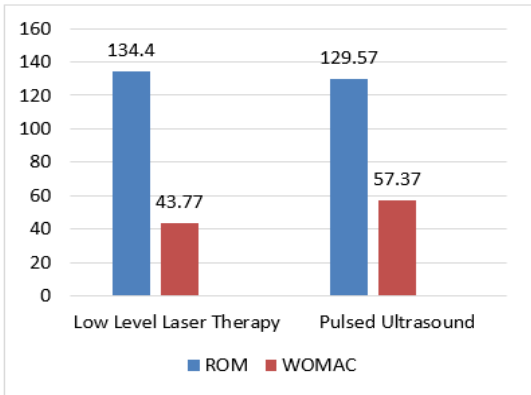
Graph-1 Shows that the values are extremely statistically significant.

Pulsed Ultrasound group:



Graph-2 Shows that the values are extremely statistically significant.

Post test values of both groups:



Graph 3: Shows that the values are extremely statistically significant.

Result

All of the participants gave their informed permission after being chosen based on inclusion and exclusion criteria. Subjects were divided into two groups. The Low Level Laser Therapy group consists of 30 subjects who received Low Level Laser Therapy with exercise and the Pulsed Ultrasound group consists of 30 subjects who received Pulsed Ultrasound with exercise.

The ROM post-test mean value in the Low Level Laser Therapy group was 134.40, while in the Pulsed Ultrasound group was 129.57. This indicates the Low Level Laser Therapy group was significantly higher than the Pulsed Ultrasound group, with a P value of <0.0001.

The WOMAC post-test mean value in Low Level Laser Therapy was 43.77, while the Pulsed Ultrasound group was 51.37. This indicates that the Low Level Laser Therapy of WOMAC score was significantly higher than the Pulsed Ultrasound group with a P value of <0.0001.

Discussion

This study's goal was to determine how effective Low Level Laser Therapy and Pulsed Ultrasound combined with exercise for osteoarthritis of knee. The Low Level Laser Therapy group consisted of 30 subjects who received Low level Laser Therapy with exercise and Pulsed Ultrasound consisted of 30 subjects who received Pulsed Ultrasound with exercise. The outcome measures were Range of motion and Western Ontario McMaster Osteoarthritis Index. Beneficial effects were significantly greater in Low Level Laser Therapy than the Pulsed Ultrasound. Statistical analysis of Low Level Laser Therapy with exercise by using Range of motion has a P value less than 0.0001 were considered statistically significant. The statistical analysis of the Pulsed Ultrasound with exercise by using the range of motion has a P value less than 0.0001 was considered statistically significant.

Enas Fawzey Youssef et al., 2016 on the efficacy of the Low Level Laser Therapy on 120 patients aged 40–50 years. The study concluded that the Low Level Laser Therapy treatment is successful in increasing ROM, reducing pain, and increasing knee flexion[12].

Michele Luise De Souza et al., 2018 Combined Ultrasound and Laser Therapy on 70 patients with symptomatic OA Knee concluded that the use of laser therapy was effective in lowering pain and enhancing functionality[13].

Adnan Afzal et al., 2021 low-powered laser treatment in the Treatment of Knee osteoarthritis on 90 patients concluded that different musculoskeletal conditions respond well to LLLT in significant ways[14].

Stausholm MB et al, 2019 concluded that at 4–8 J with 785–860 nm wavelength, low level laser therapy lessens pain and impairment in knee osteoarthritis[15].

Conclusion

The study concluded that both Pulsed Ultrasound and Low Level Laser Therapy reduced knee pain and increased ROM in osteoarthritis of the knee. But Low Level Laser Therapy was found to be effective in terms of reducing symptoms and improving performing daily tasks.

Ethical Clearance: Taken from the institutional ethical committee. ISRB number-03/ 020/ 2022/ ISRB/ SR/ SCPT

Funding: Self

Conflict of Interest: Nil

References

1. Li S, Yang M, Tang L, Zhou Y. The synergistic effects of applying low-level laser therapy plus ultrasound on pain and muscle function in patients with knee osteoarthritis: a protocol of a randomized double-blind study. Medicine. 2021 Mar 12;100(10).
2. Rayegani SM, Bahrami MH, Elyaspour D, Saeedi M, Sanjari H. Therapeutic effect of low laser therapy(LLLT) in knee osteoarthritis compared to therapeutic ultrasound. 2012:71-74
3. De Souza Simão ML, Casarino RL, Zanchin AL, Ciol H, de Aquino Junior AE, Bagnato VS. Synergic effect of therapeutic ultrasound and low-level laser therapy in the treatment of hands and knees osteoarthritis. Journal of Arthritis. 2018;7(6):1-4.
4. Zhang C, Shi J, Zhu C, Xiang T, Yi Z, Kong Y. Effect of ultrasound therapy for knee osteoarthritis: A meta-analysis of randomized, double-blind, placebo-controlled clinical trials. Int J Clin Exp Med. 2016 Jan 1;9(11):30552-20561.

5. Zeng C, Li H, Yang T, Deng ZH, Yang Y, Zhang Y, Ding X, Lei GH. Effectiveness of continuous and pulsed ultrasound for the management of knee osteoarthritis: a systematic review and network meta-analysis. Osteoarthritis and cartilage. 2014 Aug 1;22(8):1090-9.
6. Fukuda VO, Fukuda TY, Guimarães M, Shiwa S, de Lima BD, Martins RÁ, Casarotto RA, Alfredo PP, Bjordal JM, Fucs PM. Short-term efficacy of low-level laser therapy in patients with knee osteoarthritis: a randomized placebo-controlled, double-blind clinical trial. Revista Brasileira de Ortopedia (English Edition). 2011 Sep 1;46(5):526-33
7. Mezaal AL, Tajali SB, Olyaei G, Jalaie S, Alwatifi ST. Effects of low-level laser versus laser acupuncture in patients with knee osteoarthritis: a randomized controlled trial. Journal of Modern Rehabilitation. 2018;12(3):181-94.
8. Bennell KL, Hinman RS. A review of the clinical evidence for exercise in osteoarthritis of the hip and knee. Journal of science and medicine in sport. 2011 Jan 1;14(1):4-9.
9. Jang KW. The effect of low-intensity pulsed ultrasound on chondrocyte migration and its potential for the repair of articular cartilage (Doctoral dissertation, The University of lowa) (2011): 17.
10. Khanna A, Nelmes RT, Gougoulias N, Maffulli N, Gray J. The effects of LIPUS on soft-tissue healing: a review of literature. British medical bulletin. 2009 Mar 1;89(1):169-82.
11. Zeng C, Li H, Yang T, Deng ZH, Yang Y, Zhang Y, Ding X, Lei GH. Effectiveness of continuous and pulsed ultrasound for the management of knee osteoarthritis: a systematic review and network meta-analysis. Osteoarthritis and cartilage. 2014 Aug 1;22(8):1090-9.
12. Youssef EF, Muaidi QI, Shanb AA. Effect of laser therapy on chronic osteoarthritis of the knee in older subjects. Journal of lasers in medical sciences. 2016;7(2):112.
13. Jorge AE, de Souza Simão ML, Fernades AC, Chiari A, de Aquino Junior AE, Zanchin AL, Bagnato VS. Ultrasound conjugated with Laser Therapy in treatment of osteoarthritis: A case study. Journal of Sports Medicine and Therapy. 2018 Jan 24;3(1):024-7.
14. Afzal A, Ramlee MH. Low Level Laser Therapy in the Treatment of Knee Osteoarthritis: A Review. Malaysian Journal of Medicine & Health Sciences. 2021 Dec 5;17.
15. Stausholm MB, Naterstad IF, Joensen J, Lopes-Martins RÁ, Sæbø H, Lund H, Fersum KV, Bjordal JM. Efficacy of low-level laser therapy on pain and disability in knee osteoarthritis: a systematic review and meta-analysis of randomized placebo-controlled trials. BMJ open. 2019 Oct 1;9(10):e0311