RESEARCH PAPER

Effect of Shockwave Versus Low Level Laser Therapy on Recurrent post Operative Dupuytren's Contracture

Mohammed R. Gomaa[1], Wafaa H. Borhan[2], El Ashraf M. Thabet[3] and Haidy N. Ashem[4]

[1]MSc. Faculty of Physical Therapy Cairo University, Egypt.
[2]PhD, Professor of Physical Therapy, Department of physical therapy for surgery, Faculty of Physical Therapy, Cairo University, Egypt.
[3]MD, Lecturer of General Surgery, Department of surgery, Faculty of Medicine, Fayoum University, Egypt.
[4]PhD, Professor of Physical Therapy, Department of physical therapy for surgery, Faculty of Physical Therapy, Cairo University, Egypt.

Received: 16th Dec, 2025; Revised: 8th Feb 2026; Accepted: 12th Feb, 2026; Available Online: 28th Feb, 2026

ABSTRACT

Background: Dupuytren's disorder is a disease which develops gradually in stages as a result of thickening of palmar facia that provides cords and nodules and it reveals loss or decrease in ROM of the involved fingers and pain with tenosynovitis. Dupuytren's disorder is diagnosed by fibrotic stage that generate from fibrocellular proliferation. The most affected finger normally is the ring finger then the little and center fingers. This can make certain tasks more difficult of day living as face washing, brushing hair and placing hand in a glove and shaking hands1.

Purpose: This study was conducted to investigate the efficacy of shock wave and low-level laser therapy on recurrent post-operative Dupuytren's contracture.

Subjects and Methods: Sixty patients who had been diagnosed with recurrent post-operative Dupuytren's contracture with age ranged from 50 to 70 years old suffering from flexion deformities of the ring and little digits and loss of range of motion. They were divided into two equal groups in number, each group had 30 patients: Group (A): Thirty patients received extracorporeal shock wave therapy (one session per week for six weeks) in addition to the traditional physical therapy protocol (U.S, massage, stretching ex, range of motion (ROM) ex and splinting). Group (B): Thirty patients received low-level laser therapy (two sessions per week for six weeks) in addition to the traditional physical therapy protocol (U.S, massage, stretching ex, range of motion (ROM) ex and splinting). Evaluations of both groups (A and B) were done two times pre and post six weeks treatment using JAMAR hand grip dynamometer and universal goniometer.

Results: There was no significant difference between groups pre-treatment. There was a significant decrease in flexion contracture and a significant increase in hand grip strength post treatment in both groups compared with that pre-treatment. Comparison between groups post treatment revealed a significant decrease in flexion contracture and a significant increase in hand grip strength of group (A) compared with that of group (B). The percent of change in flexion contracture and hand grip strength of group A was 52.90 and 28.29% respectively, and that in group B was 23.83 and 12.77% respectively. Conclusion: Shock wave therapy and low laser therapy has a significant effect on improving the grip strength and decreasing the flexion contracture in patients with recurrent post-operative Dupuytren's contracture. Yet, the shock wave therapy had significantly higher effect on both outcomes than low laser therapy.

Keywords: *Dupuytren's contracture, Low-level laser therapy, Shock wave therapy, Hand grip dynamometer, universal goniometer.*

How to cite this article: Gomaa MR, Borhan WH, Thabet EAM, Ashem HN, Effect of Shockwave Versus Low Level Laser Therapy on Recurrent post Operative Dupuytren's Contracture. Int J Drug Deliv Technol. 2026;16(5s): 40-46. DOI: 10.25258/ijddt.16.5s.5

Source of support: Nil.

Conflict of interest: None

INTRODUCTION:

The main function of the palmar aponeurosis is to increase grip of the hand. The central portion of palmar aponeurosis occupies the middle of the palm, triangular in shape. Dupuytren's contracture or Dupuytren's disease (DD) is a progressive condition that causes the fibrous tissue of the palmar fascia to shorten and thicken. The ring finger and little finger are the fingers most commonly affected. The middle finger may be affected in advanced cases, but the index finger and the thumb are nearly always spared.[2] One or more fingers become permanently bent in a flexed position and usually begins as small hard nodules just under the skin of the palm, then worsens over time until the fingers can no longer be straightened. The ring finger followed by the little and middle fingers are most commonly affected. The condition can interfere with preparing food, writing, and other activities.[1]

Dupuytren's disease is characterized by a higher prevalence in the fifth to the seventh decades of life, and

**Author for Correspondence:*

more frequently in men than in women. Furthermore, this disease has a higher incidence in individuals with metabolic disorders (diabetes mellitus and dyslipidemia, among others), and in users of anti-retrovirals or anticonvulsants.[3] Diagnosis is usually based on signs and symptoms. Patients, initially, might be symptomless and they might present retraction of palmar fascia associated with nodules, at a later stage their ability to hold objects and pain progressively decrease. Surgery is often the main treatment in progressive DD with selective or total aponeurectomy.[4]

Recurrence is one of the most common considerations after treatment is recurrence, with long-term rates as high as 50%. Furthermore, there is definition for recurrence, which is the appearance of new Dupuytren's tissue within the area, which was initially cleared in the operation.[5] Typically reported recurrence rates range from 8 to 54 % and up to 74 % in the long term. Majority of recurrences occur in the first few years after surgery. In the long term nearly all patients should expect some form of recurrence or extension of disease.[6]

Extracorporeal shock wave therapy (ESWT) is an effective and safe non-invasive treatment option for many orthopedics diseases and its efficacy is clearly supported by positive outcome compared to placebo or alternative treatments.[7] ESWT can be therapeutically applied to various forms of fibromatosis such as penile fibromatosis and palmar fibromatosis (DD) to reduce pain, soften nodules and improved erectile function in Peyronie's disease.[8] ESWT is a safe non-invasive treatment option and it might be a tool for prevention of the progression and for treatment of DD.[4] ESWT increases tendon healing through the stimulation of cell proliferation and motility, neovascularization, and expression of critical differentiation genes.[9] ESWT has been used as a safe alternative treatment for chronic refractory musculoskeletal disease, such as plantar fasciitis Achilles tendinopathy and gluteal tendinopathy.[10]

Low level laser therapy (LLLT) is considered a safe modality and well tolerated by the patients. Moreover, it is easier to use, cheaper than ESWT, and causes less pain for the patient.[11] It has been shown to reduce levels of pro inflammatory cytokines (e.g., IL-6, TNF-α) and fibrotic markers (e.g., TGF-β1), which are elevated in Dupuytren's disease. This could theoretically slow the progression of the disease.[12] Some case reports and small-scale studies suggest that LLLT may improve joint mobility and reduce pain in Dupuytren's contracture. While this review is not specific to Dupuytren's, it supports low level laser therapy general benefits in improving soft tissue function and reducing pain.[13] LLLT has been shown in vitro to reduce myofibroblast activity, which may potentially limit disease progression as Dupuytren's contracture is driven by myofibroblast proliferation and activity.[14]

Laser therapy has been shown to soften scar tissue and reduce pain, potentially improving hand function in early or mild cases of Dupuytren's contracture.[15] Enhanced blood flow may support tissue re-modeling and healing, counteracting ischemic changes associated with palmar fibromatosis.[16] There is a positive effect of laser on pain, function, and plantar fascia thickness in patients with PF where they compared with ultrasound and extracorporeal shock wave therapy.[17]

The current study was carried to investigate the efficacy of shock wave versus low-level laser therapy on recurrent post-operative Dupuytren's contracture by measuring hand grip strength and ROM using Hand Grip Dynamometer and Universal Goniometer.

SUBJECT, MATERIAL &METHODS

Study Design

This study was designed as a Prospective, Pre/ Post-treatment, randomized controlled trial. After approval of the ethical committee of the Faculty of Physical Therapy, Cairo University- Egypt (No: P.T.REC/012/003076), the procedures of the present study were discussed thoroughly and all the participants were asked to sign a written informed consent. Sample size calculation was performed using G*POWER statistical software (version 3.1.9.2; Franz Faul, Universitat Kiel, Germany); and revealed that the required sample size for this study was 30 subjects in each group. Calculation is made with α=0.05, power = 90% and effect size = 0.86. The randomization of 60 patients was performed with the closed envelope method, and two groups were formed with 30 (Group A, ESWT) and 30 (Group B, LLLT) participants, respectively (Figure 1).

Participants

Sixty patients with their ages ranged from 50 to 70 years participated in this study. They were divided randomly into two equal groups, each group had 30 patients: **Group A** (extracorporeal shock wave group): this group was composed thirty patients who had been diagnosed with recurrent post-operative Dupuytren's contracture and suffering from flexion deformities of the ring and little digits and loss of range of motion. They were managed with extracorporeal shock wave therapy (ESWT) in addition to the traditional physical therapy protocol (U.S, massage, stretching ex, range of motion (ROM) ex and splinting). The chosen protocol of ESWT was done at a frequency of 6–8 Hz with 1700 pulse/session at 0.18 mj/cm2 one time per week for 6 weeks. **Group B** (low-level laser therapy group): This group was composed thirty patients who had been diagnosed with recurrent post-operative Dupuytren's contracture and suffering from flexion deformities of the digits and loss of range of motion. They patients received low-level laser therapy (LLLT) in addition to traditional physical therapy protocol (U.S, massage, stretching ex, range of motion (ROM) ex and splinting). The chosen protocol of (LLLT) consisted of 30 mW, the power of 0.50 W, the dosage of 50 J/cm^2 and administered 100-second exposure duration for every nodule and painful area two times weekly for 6 weeks. All patients were evaluated before and after treatment application. The evaluation procedures were achieved

through hand grip dynamometer and universal goniometer to measure hand grip strength and range of motion in both groups of the study. Data obtained from both groups regarding flexion contracture and hand grip strength were statistically analyzed and compared. Participants were excluded if they were pregnant or planned of getting pregnant during the treatment period, patients who did not accept to receive a treatment for their contractures, patients who were contraindicated for ESWT, patients suffering

from psychological problems, patients with mental disorders, patients with coagulation defects and presence of a chronic, neurological, or neuromuscular disorder that affected the hands.

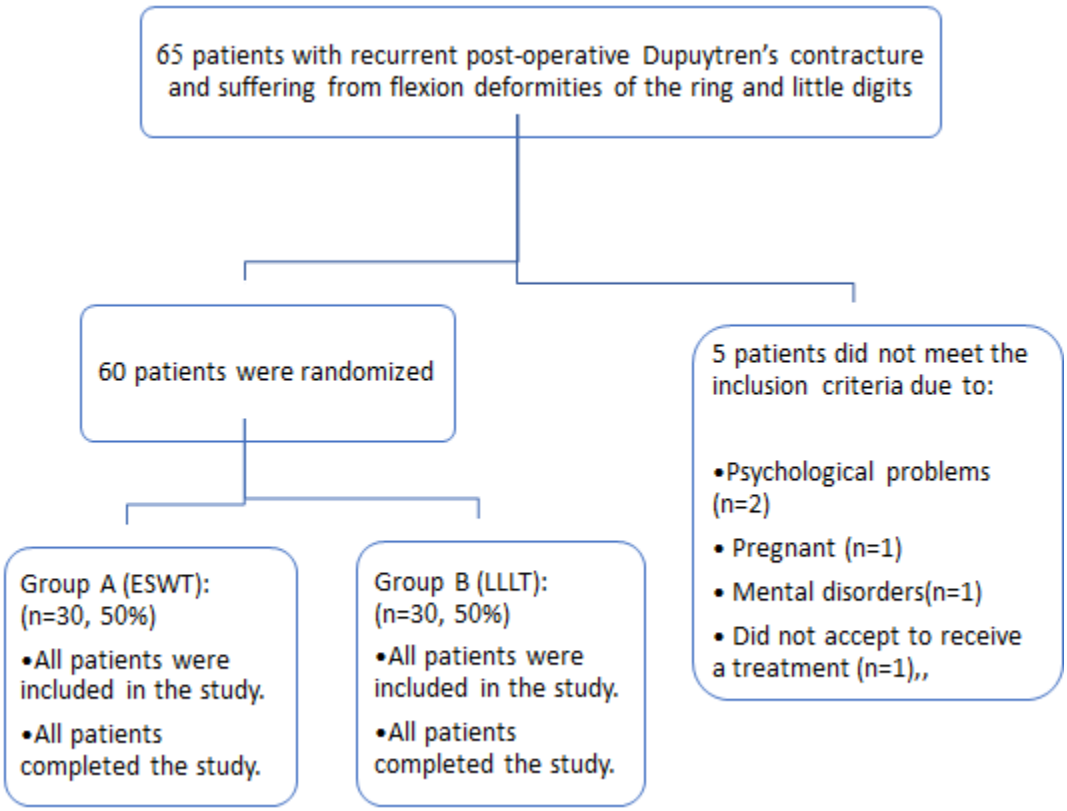

Figure 1. Study flowchart.

Intervention:

Detailed medical history was taken from each participant in current clinical trials` groups before starting the study and was recorded in a data recording.

The extracorporeal shockwave treatment (group A) application was performed with the patient in sitting on a gurney with the elbow flexed at 30° and the forearm supinated. The application site cleaned with povidone-iodine solution, and a gel applied on the skin to enhance conductivity. There was one no any local anaesthesia applied for patient. The regions with nodules marked, and the probe circularly moved around this mark. The probe of the ESWT device positioned 90° tangent to the pain site and nodules areas and circularly moved around them. The physiotherapist performed the treatment using the ESWT device (Beco ESWT, Model Number: SW9.) at a frequency of 6 to 8 Hz with 1700 pulse/session at 0.18 mJ/cm2 at peak pressure varied from 1 to 3 bars once a week [21] followed by traditional physiotherapy exercises as (ROM exercise, scar massage, tendon gliding exercise and splinting) for six weeks. Ask patient every 500 shocks if the intensity is tolerable to increase pressure 0.5 bar (if tolerated). No hot or cold therapy following ESWT application. The physician and the patient wore earmuffs as the device operated with high noise.

The low-level laser treatment (group B) application was performed with the patient in sitting position with his forearm rest on table and his hand rest in supination position. The painful palmar sites and nodules areas was irradiated with the laser probe. Laser therapy was applied at a wavelength of 830 nm was used by laser therapy device (The Intelect® Mobile Laser by Chattanooga, Class 3B). Treatment consisted of 30 mW, the power of 0.50 W, the dosage of 50 J/cm^2 (3 J) and administered 100-second exposure duration for every nodule and painful area two times weekly [22] followed by traditional physiotherapy exercises as (ROM exercise, scar massage, tendon gliding exercise and splinting) for six weeks.

Outcome Measures

Therapeutic grip strength degree was assessed by a Jamar dynamometer with one-minute intervals between

measurements and the average of the three measurements was noted. The patient seated and the shoulder adducted, the elbow was flexed to 90º of flexion, while the forearm remained in a state of neutral rotation. In addition, the wrist was at neutral (to 30º extension while gripping). Patient was asked to grip with full force for at least 2 seconds (for full muscle recruitment). The examiner provided verbal encouragement (i.e., "Ready? Okay, go! Harder, Harder!") Until grip strength peaked, then said, "Stop." Grip strength was recorded, rounding to the nearest pound, and the dial had been returned to zero. The measurement of ROM was done before the start of the study and after 6 weeks of treatment.[19]

To assess the range of motion (ROM) of the fingers (specially the ring and little fingers), we used a 360-degree universal goniometer from the lateral position, we typically focus on the metacarpophalangeal (MCP) to detect flexion contracture angle. The patient should be seated comfortably with the forearm supported and the hand resting on a flat surface in a supination position. The forearm and wrist should be in relaxed rotation to allow lateral observation of finger joints. Axis on medial aspect of the MCP joint, stationary arm parallel or aligned with the medial midline (longitudinal axis) of the metacarpal bone and movable arm parallel or aligned with the medial midline (longitudinal axis) of the proximal phalanx. patient was instructed to slowly extend the finger at the MCP joint and the angle of flexion was recorded. Therapist take 3 measurements for consistency and average. The measurement of ROM was done before the start of the study and after 6 weeks of treatment.[20]

STATISTICAL ANALYSIS:

Unpaired t-test was conducted for comparison of age between groups. Chi-squared test was conducted for comparison of sex distribution between groups. Normal distribution of data was checked using the Shapiro-Wilk test. Levene's test for homogeneity of variances was conducted to test the homogeneity between groups. Unpaired t test was conducted for comparison of flexion contracture and hand grip strength between groups and paired t test was conducted for comparison between pre and post treatment. The level of significance for all statistical tests was set at $p < 0.05$. All statistical analysis was conducted through the statistical package for social studies (SPSS) version 25 for windows (IBM SPSS, Chicago, IL, USA).[23]

INFORMED CONSENT

All participants in this research gave their informed permission.

RESULTS:

- **Subject characteristics:**

Sixty patients had a recurrent post-operative Dupuytren's contracture participated in this study. Table (1) shows the subject characteristics of group A and B. There was no significance difference between groups in age and sex distribution ($p > 0.05$).

Table (1). Comparison of subject characteristics between group A and B:

	Group A	Group B			
	Mean ±SD	Mean ±SD	MD	t- value	p-value
Age (years)	59.33 ± 6.18	59.97 ± 6.34	-0.64	-0.39	0.69
Sex, n (%)					
Female	7 (23%)	6 (20%)		($\chi^2 = 0.09$)	0.75
Male	23 (77%)	24 (80%)			

SD, Standard deviation; **MD,** Mean difference; **χ^2,** Chi squared value; **p value**, Probability value

- **Effect of treatment on flexion contracture and hand grip strength:**

i. Within Group Comparison:

There was a significant decrease in flexion contracture and a significant increase in hand grip strength post treatment in both groups compared with that pre-treatment ($p < 0.001$). The percent of change in flexion contracture and hand grip strength of group A was 52.90 and 28.29% respectively, and that in group B was 23.83 and 12.77% respectively. (Table 2).

ii. Between Group Comparison:

There was no significant difference between groups pre-treatment ($p > 0.05$). Comparison between groups post treatment revealed a significant decrease in flexion contracture (effect size = 1.72) and a significant increase in hand grip strength (effect size = 0.73) of group A compared with that of group B ($p < 0.01$). (Tables 2).

Table (2). Mean VSS and scar pliability pre and post treatment of group A and B:

	Pre treatment	Post treatment				
	Mean ±SD	Mean ±SD	MD	% of change	t- value	p value
Flexion contracture (degrees)						
Group A	20.53 ± 5.14	9.67 ± 3.45	10.86	52.90	16.63	0.001
Group B	21.23 ± 5.79	16.17 ± 4.06	5.06	23.83	9.23	0.001
MD	-0.7	-6.5				
t- value	-0.49	-6.68				
	p = 0.62	**p = 0.001**				

Cohen effect size		**1.72**				
Hand grip strength (kg)						
Group A	15.20 ± 2.76	19.50 ± 2.73	-4.3	28.29	-18.25	0.001
Group B	15.43 ± 2.86	17.40 ± 3.02	-1.97	12.77	-5.15	0.001
MD	-0.23	2.1				
t- value	-0.32	2.83				
	p = 0.75	**p = 0.006**				
Cohen effect size		**0.73**				

SD, Standard deviation; **MD,** Mean difference; **p value,** Probability value

DISCUSSION

Shockwave therapy involves applying acoustic waves to the affected area, which may promote tissue regeneration and improve elasticity in the palmar fascia. Preliminary studies suggest that this non-invasive method can enhance finger mobility and reduce pain.[24] Similarly, LLLT utilizes specific wavelengths of light to stimulate cellular activity, potentially reducing inflammation and promoting healing. Early research indicates that LLLT may improve mobility and slow the progression of contractures, making it a promising avenue for reducing recurrence rates after surgical management.[25]

Both therapies require further investigation through well-designed clinical trials to establish their efficacy and optimal treatment protocols.

In our study there was a significant decrease in flexion contracture and a significant increase in hand grip strength post treatment in both groups compared with that pre-treatment ($p < 0.001$).

Taheri et al., described a 64-year-old farmer with Dupuytren's disease in both hands with flexion contracture of the 4th finger. The patient was treated with 6 weekly radial shock wave treatments. The patient had improved range of motion and better hand function after the treatment.[26] Abd Elbaky et al., agreed with our results in their study evaluating the effect of extracorporeal shockwave therapy on palmar fibromatosis, as they reported that there was a significant increase in hand grip strength post treatment in the shock wave therapy groups compared with that pretreatment (P value < 0.001).[27]

There is recent evidence that LLLT may have a preventive capacity which enhance muscle strength and accelerate muscle regeneration.[28] Laser therapy for tendonopathy has been demonstrated to have statistically significant effects in pain relief, increasing grasp force and increasing ROM of wrist joints.[29] Similar results which may explained by the work of Xu et al., who found that low level laser therapy seems to improve muscle performance via the energy metabolism in cells by stimulating photochemical events and enhancing mitochondrial function in muscle cells.[30]

In another study, Desoky et al., in their study assessing the effect of low laser therapy on hand range of motion, they reported a statistically insignificant difference ($p>0.05$) regarding metacarpophalangeal joints range of motion.[31]

In our study there was a significant decrease in flexion contracture and a significant increase in hand grip strength of group A compared with that of group B ($p < 0.01$). The results of this study showed that the shock wave therapy and low-level laser therapy are beneficial therapeutic modalities in flexion contracture and hand grip strength in patients with recurrent post-operative Dupuytren's contracture. Yet, the shock wave therapy had significantly higher effect on both outcomes than low laser therapy.

However, the number of trials adopted in the analyses was relatively small (only two and five trials, respectively). Moreover, a recent systematic review reported no difference between ESWT and laser therapy in reducing pain intensity at three months follow-up in cases of plantar fasciitis (PT).[32] Notarnicola et al., reported that the functional recovery was statistically significant in the shock wave group at all follow-ups and in the laser and stretching groups at the end of treatment (T1) and after 1 month (T2) ($p<0.01$). Also, the extension deficit recovery as regards the MCP and PIP joints was statistically significant in the SW group at T1 and T2 ($p</= 0.01$) and in the stretching group at T1 ($p<0.01$).[24] Ulusoy et al., 2017 used magnetic resonance imaging (MRI) to compare the effectiveness of ESWT, LLLT, and US on the relief of pain, foot function, and plantar fascia thickness. Sixty patients with chronic plantar fasciitis (PT) were randomized into 3 groups (n= 20) in each group. They reported that plantar fascia thickness had decreased significantly on MRI in all the 3 groups. The success rate of treatment was 70.6% in the LLLT group, 65% in the ESWT group, and 23.5% in the US group at 1 month after treatment. LLLT and ESWT caused higher improvement in foot function and pain. LLLT was significantly superior to ESWT in reducing pain.[17]

Gungor et al., in their study comparing the efficacy of extracorporeal shockwave therapy and laser therapy in the treatment of de Quervain tenosynovitis, they found that, in both groups, the mean grip strength value was the lowest before the treatment and the highest at three months of follow-up. Yet, the difference between the groups in terms of grip strength values measured before the treatment and at three weeks and three months was not statistically significant ($p>0.05$).[33]

Conversely, a more recent systematic review by Ferlito et al., 2023 suggests that LLLT is superior to ESWT in reducing pain intensity in the short-term follow-up in patients with PF, demonstrating a large effect size ($MD = -20.94$).[34]

CONCLUSION

Shock wave therapy and low laser therapy has a significant effect on improving the grip strength and decreasing the flexion contracture in patients with recurrent post-operative Dupuytren's contracture. Yet, the shock wave therapy had significantly higher effect on both outcomes than low level laser therapy.

DECLARATION OF CONFLICTING INTERESTS:

The authors declared no conflicts of interest with respect to the authorship and/or publication of this article.

FUNDING:

The authors received no financial support for the research and/or authorship of this article.

REFERENCES

1. **Henry M. (2014):** "Dupuytren's disease: current state of the art." Hand (NY); 9:1–8.
2. **Tastos J.P., Richmond J.M., Cummings J.R., Hardesty R. and Amiel D. (2016):** "Radiofrequency Microtenotomy for elbow Epicondylitis: midterm results." Am J Orthop (Belle Mead NJ); 45(1):29–33.
3. **Dolmans G.H., Bock G.H. and Werker P.M. (2012):** "Dupuytren diathesis and genetic risk." J Hand Surg Am; 37(10):2106-11.
4. **Balaguer T., David S., Ihrai T., et al., (2009):** "Histological staging and Dupuytren's disease recurrence or extension after surgical treatment: a retrospective study of 124 patients." J Hand Surg Eur; 34:493–6.
5. **Kan H.J., Verrijp F.W., Hovius S.R. et al., (2017):** "Recurrence of Dupuytren' s contracture: a consensus-based defnition." PLOS ONE; 12:1–10.
6. **Hurst L. (2011):** Dupuytren's contracture. In: Hotchkiss RN, Pederson WC, Kozin SH, Wolfe SW, editors. Green's operative hand surgery. 6th ed. Philadelphia: Churchill Livingstone; 2011. p. 141–58.
7. **Schmitz C., Császár N.M., Milz S. et al., (2015):** "Efficacy and safety of extracorporeal shock wave therapy for orthopedic conditions: a systematic review on studies listed in the PEDro database." Br Med Bull; 116:115–38.
8. **Palmieri A., Imbimbo C., Longo N., Fusco F., Verze P., Mangiapia F. et al., (2009):** "A first prospective, randomized, double-blind, placebo-controlled clinical trial evaluating extracorporeal shock wave therapy for the treatment of Peyronie's disease." European urology; 56(2):363–9.
9. **Visco V., Vulpiani M.C., Torrisi M.R., Ferretti A., Pavan A. and Vetrano M. (2014):** "Experimental studies on the biological effects of extracorporeal shock wave therapy on tendon models." A review of the literature. Muscles Ligaments Tendons J; 4(3):357–361.
10. **Lou J., Wang S., Liu S. and Xing G. (2017):** "Effectiveness of Extracorporeal Shock Wave Therapy Without Local Anesthesia in Patients With Recalcitrant Plantar Fasciitis: A Meta-Analysis of Randomized Controlled Trials." American journal of physical medicine & rehabilitation; 96(8):529–34.
11. **Hashmi J.T., Huang Y.Y., Osmani B.Z., Sharma S.K., Naeser M. A. and Hamblin M. R., (2010):** "Role of low-level laser therapy in neurorehabilitation." *PM&R*, 2(12 Suppl 2), S292–S305.
12. **Hamblin MR. (2017):** "Mechanisms and applications of the anti-inflammatory effects of photobiomodulation." AIMS Biophys;4(3):337–361.
13. **Cotler H.B. et al., (2010):** "Low-level laser therapy for musculoskeletal pain: a systematic review and meta-analysis." Phys Med Rehabil Clin N Am.;21(4):739–751.
14. **Hawkins D. & Abrahamse H. (2006):** "Effect of multiple exposures of low-level laser therapy on the cellular responses of wounded human skin fibroblasts." Photomed Laser Surg ;24(6):705-714.
15. **Cotler, H. B., Chow, R. T., Hamblin, M. R., & Carroll, J. (2015):** "The Use of Low Level Laser Therapy (LLLT) For Musculoskeletal Pain." MOJ Orthopedics & Rheumatology, 2(5), 00068.
16. **Rohde C, Chiang A, Adipoju O, Casper D, Hamblin MR. (2018):** "Photobiomodulation therapy in rehabilitation: effects on pain and inflammation." Pain Management.;8(6):475–487.
17. **Ulusoy A., Cerrahoglu L. and Orguc S. (2017):** "Magnetic resonance imaging and clinical outcomes of laser therapy, ultrasound therapy, and extracorporeal shock wave therapy for treatment of plantar fasciitis: a randomized controlled trial." J Foot Ankle Surg 56(4):762–767.
18. **Izzet Kirkaya, Celil Kaçoglu and Beyza Şeno. (2021):** "Reliability and concurrent validity of iPhone level application for measuring lower limb active flexion and extension range of motions in physical education students." Physical Education of Students, 25(3), 164–171.
19. **Spark T., Godlwana L. and Ntsiea M. V., (2018):** "Range of movement, power and pinch grip strength post flexor tendon repair". SA Orthopaedic Journal, 17(1), 47-54.
20. **Norkin C.C. & White D.J. (2016):** "Measurement of joint motion: a guide to goniometry." FA Davis; 2016 Nov 18.
21. **Aykut S., Aydın C., Ozturk K., Arslanoglu F. and Kilinc C.Y. (2018):** "Extracorporeal Shock Wave Therapy in Dupuytren's Disease." Med Bull Sisli Etfal Hosp; 52(2):124–128.

22. **Allameh F., Razzaghi M., Rayegani S.M., Fallah-Karkan M., Ranjbar A., Rahavian A. et al., (2019):** "Laser therapy for Peyronie's disease: a randomized control double-blind pilot study." J Lasers Med Sci ;10:37–42.

23. **Chan YH. (2003b):** Biostatistics 103: Qualitative Data-Tests of Independence. Singapore Med J.;44(10): 498-503.

24. **Notarnicola A, Maccagnano G, & Rifino F. et al., (2017):** "Short-term effect of shockwave therapy, temperature controlled high energy adjustable multi-mode emission laser or stretching in Dupuytren's disease." a prospective randomized clinical trial.

25. **Lawrence J. and Sorra K., (2024):** "Photobiomodulation as Medicine: Low-Level Laser Therapy (LLLT) for Acute Tissue Injury or Sport Performance Recovery." Journal of Functional Morphology and Kinesiology; 9 (4), 181.

26. **Taheri, P., Salek, N., Mousavi, M., & Maghroori, R. (2022):** "The Effect of Shock Wave Therapy on Improving the Symptoms and Function of Patients with Dupuytren's Contracture." Advanced Biomedical Research, 11(1), 3.

27. **Abd Elbaky, A. M., Abo Alfotooh, A., Saafan, K. I., & Saad, M. A. M. (2021):** "Effect of extracorporeal shockwave therapy on palmar fibromatosis." Journal of Life Science and Biomedicine, 11(1), 13–19.

28. **Baltzer W.A., Stosch D., Seidel F., et al. (2017):** "Low level laser therapy: A narrative literature review on the efficacy in the treatment of rheumatic orthopaedic conditions." Z Rheumatol; 76: 806-12.

29. **Chang W.D., Wu J.H., Yang W.J., Jiang J.A., (2010):** "Therapeutic effects of low-level laser on lateral epicondylitis from differential interventions of chinese-western medicine: systematic review." Photomed Laser Surg; 28:327-36.

30. **Xu, X., Zhao, X., Liu, T. C. Y., & Pan, H. (2008):** "Low-intensity laser irradiation improves the mitochondrial dysfunction of C2C12 induced by electrical stimulation." Photomedicine and Laser Surgery, 26(3), 197–202.

31. **Desoky H. D., Abd El-Wahab M. A. N. & El-Din S. M. N., (2019):** "Effect of low level laser therapy on hand function performance of children with type I diabetes cheiroarthropathy." Journal of Medical Sciences(19), 56–62.

32. **De La Barra Ortiz H.A., Jélvez F., Parraguez D. et al., (2023):** "Effectiveness of high-intensity laser therapy in patients with plantar fasciitis: A systematic review with meta-analysis of randomized clinical trials." Advances in Rehabilitation, 37(3), 34–51.

33. **Güngör, Z., & Güngör, E. (2024):** "The comparison of the efficacy of extracorporeal shockwave therapy and high-intensity laser therapy in the treatment of de Quervain tenosynovitis." Turkish Journal of Physical Medicine and Rehabilitation, 71(1), 28–36.

34. **Ferlito J.V., Silva C.F., Almeida J.C. et al., (2023):** "Effects of photobiomodulation therapy (PBMT) on the management of pain intensity and disability in plantar fasciitis: systematic review and meta-analysis." Lasers in Medical Science, 38, Article 163.