Comparing the Effect of Low-Level Laser Therapy Versus Therapeutic Ultrasound After Colles' Fracture (Comparison Study)

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ABSTRACT: Background: The Colles' fracture is the most common fracture site in the upper extremity; it causes functional problems and it can result in some disabling complications. Objective: The purpose of this study was to investigate the effect of Low-level laser therapy versus therapeutic ultrasound after Colles' fracture fixation. Method:Fourty patients were assigned randomly into two groups (Group A and Group B) with ages ranged from 18-45ys. Group A consisted of fifteen female patients and five male patients, and received Low-level laser therapy, group B consisted of fifteen female patients and five male patients, and therapeutic ultrasound for 3 times per week for 6 weeks. Patients were evaluated pre and post-treatment for the function of the wrist joint, grip strength, and wrist joint's ROM. Results:When comparing patients in group (A) who received LASER therapy, and patients in group B who received Therapeutic ultrasound, we observed clinical difference but it was only statistically significant in favor of group (A) patients in terms of pain and function. Group (A) had a better score in functional disability but it was statistically significant, also had a better score in grip strength but it was not statistically significant. However group (B) had better scores in the range of motion of flexion, extension, radial deviation, and ulnar deviation but it was not statistically significant and also had lower scores in the patient-reported in grip strength. Conclusion: It can be concluded that both Low-level laser therapy and therapeutic ultrasound after Colles' fractures fixation improved pain, patient hand function, grip strength, and range of motion. Both of similar degrees of improvement, however low-level laser therapy had more improvements than therapeutic ultrasound in the wrist pain and function.

Key Word: Colles' fracture, Low-level laser therapy, Therapeutic ultrasound

1. Introduction

Colles' fracture is at the particular distal radius and commonly the lower radial and is dorsally and side to side angulated along with a rotating deformity in supination **(1)**. This is a very typical

extra-articular fracture that arises as to the results of the fall on an outstretched hand. It is typically seen in all age groups and demographics, particularly increased in osteoporotic individuals [(2)].

This fracture may result in some difficulties as persistent pain in addition to the loss of motion combined with moderate swelling of the particular distal radius. Increased angulation of distal radius may lead to an incapability to grasp objects following a plaster cast [(3)]. Impairment throughout the range of motion in addition to strength after distal radius fractures may result in difficulty along with the functional task **(4).**

Physiotherapy in many cases is included in the rehabilitation involving patients with these accidental injuries. The activities and tasks of these professionals usually overlap. Rehabilitation interventions simply by physiotherapists focus on protecting against complications associated with the particular fracture and/or treatment and even on optimizing movement in addition to the physical function of the patient[(5)].

The particular goal for rehabilitation followingwrist fractures is to be able to achieve complete and fast recovery of ROM, strength, and performance involving the wrist and Hands[(6)]. Hence, for the development of functional outcome, has to pay focus to the postoperative therapy period[(7)]. A patient would likely need a more effective treatment procedure without really stressing the bone which may prevent the unfavorable side effects as effectively as the central reorganization that takes place a result of immobilization. This may lead to being able to a temporary forgetting regarding| the function of the particularly affected limb[(8)], and even results in the ineffectiveness of the central management of movements. Immobilization seemed to be shown to result quite rapidly in changes involving motor and sensory diagrams in the brain involving peripheral organs such as a finger, arm[(9), (10)].

For instance**, Langer et al., [(9)]** showed some sort of decrease in cortical in the left motor and somatosensory region as well as a decrease in the gray matter in the corticospinal tract after least 2 weeks of the arm or leg immobilization.

Physiotherapy rehabilitation can be effective exercises (under control over the particular patient) and passive (usually performed by the specialist while the patient is still 'passive') mobilization exercises, passive motion devices, conditioning exercises, heat treatment, in addition to massage [(5)].

Ultrasound utilized to manage the three most common impairments of Colles' fracture |and they are generally soft tissue inflammation, tissue extensibility, and scar tissueremodeling[(11)]. Ultrasound (US) been traditionally used an adjunct modality for the particular management of many musculoskeletal conditions. Therapeutic ultrasound may be the use of alternating compression and rarefaction of reasonable waves for therapeutic. When ultrasonic energy is induced into an attenuating material such as tissues, the amplitude of the particular wave will decrease the distance. This attenuation will be due to either absorption or the spreading of sound waves [(12)].

Low-Level Laser Therapy (LLLT) sometimes known as Low-Level Light Therapy or Photobiomodulation (PBM) is a low-intensity light therapy. The effect is photochemical, not thermal. The light triggers biochemical changes within cells and can be compared to the process of photosynthesis in plants, where the photons are absorbed by cellular photoreceptors and trigger chemical changes[(13)].

It hypothesized that there was no significant difference between Low-Level Laser and Therapeutic ultrasound on the wrist joint pain, range of motion, grip strength, and patient-rated wrist evaluation after Colle's fracture.

2. Material and Methods

In this study fourty patients recruited from the orthopedic outpatient clinic of Sohag General Hospital who has suffered Colles' fracture and treated with a plaster cast. Patients were randomly allocated to one of two groups equal in number, group (A) low-level laser therapy (n=20) and group (B) therapeutic ultrasound (n=20). They were referred to this study from January 2019 to April 2020.

Inclusion criteria:

All patients had Colles' fracture were enrolled in the current study if they met all of the following criteria:

1. Patients group with radiological diagnosis of post-Colles' fractures after 6 weeks of the cast.
2. Patients with limited ROM wrist.
3. Fourty patients are their age range from 18-45 years old.
4. Fourty patients (30 female and 10 male).

Exclusion criteria:

Subjects of Colles' fracture group were excluded if they had:

1. Patient with Neuromuscular injuries.
2. The wrist or forearm motion deficits were presented before the wrist injury to the degree that it affected the patient's daily activity.
3. Osteopenia.
4. Patient with both radius and ulna fractures.

Randomization method:

Each participant assigned a unique number. These numbers were written on a piece of paper. The pieces of paper were mixed in a container and then the numbers selected by another physical therapist. Finally, the assigned number put in a closed envelope and delivered to the researcher at beginning of treatment.

Intervention:

All patients were received sixteen treatment sessions.

Group A:

Patients received low-level laser therapy with a treatment program in which 830 nm LLLT (average power 60 mW, peak power 8 W, 10 Hz, 10 minutes, and 9.7 J/cm) will be administered three times per week for 6 weeks.

Group B:

Patients received therapeutic ultrasound with an intensity of 1.5 w/cm2 and a frequency of 3 MHz for 5 minutes will be administered three times per week for 6 weeks.

Outcome measures post radial fracture

The researcher chose outcome measures that can be easily understood and administered and have consistent reliability and validity over a wide array of demographic groups **(14).**

The hand-held dynamometer is considered to be a reliable instrument in evaluating grip strength and is used widely in rehabilitation it is used to measure the force of flexor muscles of the hand, generated during gripping the dynamometer [(15)].

The patient-rated wrist evaluation score is a reliable, valid measure of patient-rated pain and disability. It is a patient self-rated, joint-specific questionnaire that enquires about symptoms of the wrist pain and functional limitations concerning ADL [(16; 17)].

The Myrin OB goniometer used as an alternate instrument to the universal goniometer for assessing the range of motion at some joints. It consists of a fluid-filled rotatable container mounted on a plate. The container has a compass needle that reacts to the earth's magnetic field, an inclination needle that is influenced by the force of gravity, and a scale on the container floor marked in 2º increments (one minor unit = 2º and one major unit = 10º). The compass needle measures movements in the horizontal plane; the inclination needle measures movements in the frontal and sagittal planes. Two straps with Velcro fastenings are supplied to attach the goniometer to the body segment, and two plastic extension plates are also supplied to position the goniometer for certain joint measurements[(18)].

Data Analysis

The Independent variables were Low-Level Laser Therapy and Therapeutic Ultrasound and the dependent variable was Pain, Function, Hand Grip Strength, and wrist ROM. Analyses were performed using the SPSS statistical software package. Paired't' test was used for the measurement of pre-testand post-test values of group A and B. Unpaired 't' test were used tocompare the post-test values of Group A and B. P values ≤ 0.05 were considered significant. Ethical approval was obtained by the Research Ethics Committee of the National institute of laser enhanced science , Cairo university, Egypt.

3. Results

In this study 30 femaleand 10 male patients were assigned randomly into 2 groups; Group A (n=20) their mean age was 30.8± 8.98years old. Group B (n=20) their mean age was 29.6± 7.63 years old fig (1).

The results at the end of the treatment program revealed that group A that received Low-Level Laser showed a statistically significant difference than Group B in wrist pain, the mean value of group A 14±1.70, and the mean value of group B 20.4±3.31with t test= 6.580 and p value= 0.0001 table (1).

Atthe function, revealed a statistically significant difference between the mean value of group A 38.93±1.57 and the mean value of group B 44.66±6.03 with t test= 3.535 and p value= 0.001 table (1).

Atgripstrength, revealed no statistically significant difference between the mean value of group A 5.65±2.49 and the mean value of group B 4.19±1.72 with t test= 1.529 and p value= 0.144 table (1).

Atwrist range of motion flexion, extension, radial deviation, and ulnar deviationgroup A 37.9±5.77 and the mean value of group B 46.6±8.53 with t test=1.886 and p value=0.096, group A 40±12.24and the mean value of group B 47.8±7.69 with t test=1.206 and p value=0.262, group A 12.6±5.80 and the mean value of group B 14.2±5.84 with t test= 0.432 and pvalue=0.677, group A 18.8±6.6 and the mean value of group B 20±9.0 with t test= 0.238 and p value=0.818 table (2).

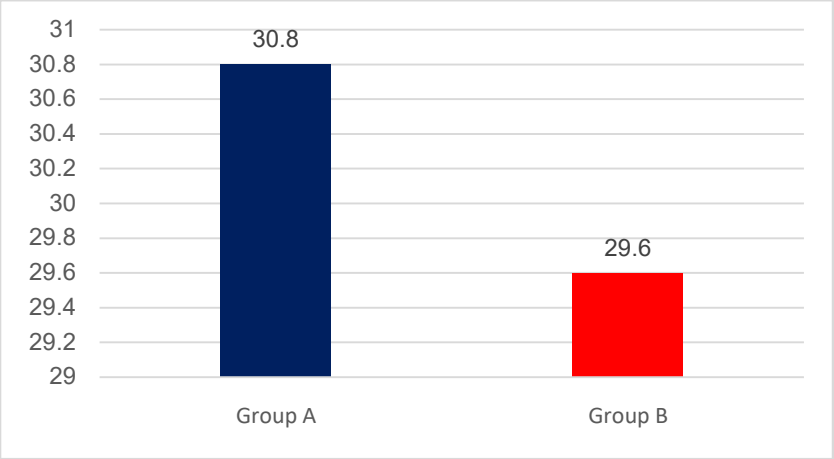

Fig (1): Comparison between the mean values of Age in years in the two studied groups.

Table (1) Comparison between the mean values of the wrist pain, function, grip strength and wrist ROM in the two studied groups after treatment.

Parameters	Group A	Group B	t- value	P value
Pain	14±1.70	20.4±3.31	6.58	0.0001***
Function	38.93±1.57	44.66±6.03	3.535	0.001 **
Grip strength (Kg)	5.65±2.49	4.19±1.72	1.529	0.144 (NS)
Wrist ROM	37.9±5.77	46.6±8.53	1.886	0.096 (NS)

Data are expressed as mean ± SD.
*** Highly significant difference at $\alpha < 0.0001$
**High significant difference at $\alpha < 0.001$
(NS) None significant difference at $\alpha > 0.05$

Table (2) Comparison between the mean values of ROM variable in the two studied groups after treatment.

Parameters	Group A	Group B	t-value	P value
Flexion (degree)	37.9±5.77	46.6±8.53	1.889	0.096 (NS)
Extension (degree)	40±12.24	47.8±7.69	1.206	0.262 (NS)
Radial deviation (degree)	12.6±5.80	14.2±5.84	0.432	0.677 (NS)
Ulnar deviation (degree)	18.8±6.6	20±9.0	0.238	0.818 (NS)

Data are expressed as mean ± SD. (NS) None significant difference at $\alpha > 0.05$

4. Discussion

This study investigated the effects of Laser therapy versus therapeutic ultrasound in the rehabilitation after stable Colles' fracture. This study used different outcome measures to assess the effects of the treatments on the pain functional disability, grip strength, and wrist ROM. The researcher chose a sample of youth who sustained a relatively high energy fall which is one of the common causes of Colles' fracture [19]. Although postmenopausal women have nearly five times more likely than men, [20].

LASER therapy of wrist joint:

When comparing patients in group (A) who received LASER therapy, and patients in group B who received Therapeutic ultrasound, we observed clinical difference but it was only statistically significant in favor of group (A) patients in terms of pain and function. Group (A) had a better score in functional disability but it was statistically significant, also had a better score in grip strength but it was not statistically significant. However, group (B) had a better score in the range of motion of flexion, extension, radial deviation, and ulnar deviation but it was not statistically significant and had lower scores in the patient-reported in grip strength.

This study confirms the previous report that LLLT and Therapeutic ultrasound early intervention helps to improve pain, range of motion, grip strength, and reduce disability.**Chang et al. (21)** employed a diode laser with a wavelength of 830 nm, an energy density of 9.7 J/cm2, and average power of 60mW a diode laser (9.7 J/cm2) was used to treat closed bone fractures in wristsand hands, and the experimental results indicated that thetreatment provided effective pain relief and improved themuscle strength and functional ability of patients. This study revealed that the pain of acute fractures was significantly reduced after LLLT. A significant difference in the VAS scores was observed in both the laser and placebo groups after treatment and at the follow-up, compared with those at the baseline. However, only the laser group demonstrated significant improvement in the Quick DASH results and hand and finger grip strength measures after treatment.

This consistent with **Brosseau et al. [(22)]** who demonstrated that LLLT relieved pain and exerted beneficial effects on acute and chronic musculoskeletal diseases. **Bjordal et al. [(23)]** used LLLT to treat patients with degenerative arthritis for a brief period, and then compared the results with the outcomes of control patients who received either electrical stimulation or no treatment; they observed that LLLT produced a pain-relieving effect for up to 4 weeks after treatment.

Bjordal et al. [(24)] suggested that a laser wavelength of 830 nm and dosages between 6 and 10 J, can deeply penetrate tissue, and that satisfactory absorption can be achieved, thereby inducing anti-inflammatory effects to treat orthopedic diseases

This is in accordance with our results that **Schindl et al. [(25)]** reported that LLLT has shown some medical benefits. Some of these include increasing ROM, increasing blood flow, increasing tissue regeneration, decreasing inflammation, and decreasing pain. Skin circulation has also been reported to increase in diabetic patients due to LLLT.

This contrasts with our study, **Kobordo[(26)]** that concluded there were no significant differences between groups for pain in this study, as measured using a VAS scale. Interestingly, the LLLT group was similar in pain ratings compared to the sham and control groups. This is like**Baroni et al. [(27)]** who also found no differences between groups. This differs, however, from the findings of **Douris et al. [(28)]** who found significant reductions in pain between groups with the application of LLLT (applied at 8 J/cm2 held for 80 s at 3 different sites near the musculotendinous junction of the biceps brachii, totaling 24 J delivered to biceps brachii).

Baroni et al. [(27)] found a significant effect of LLLT on muscle strength (as measured by maximal voluntary contractions) at 24 and 48 hours post-exercise when applied prophylactically (30 J for 30 seconds at 6 different sites- 180 J for the quadriceps musculature).

Therapeutic ultrasound of wrist joint:

Draper[(29)] and Kaltenborn[(30)], stated that thermal ultrasound used in concert with joint mobilizations was effective in restoring ROM in hypo-mobile wrists post-injury or when

immobilized after surgery. Ultrasound also increased patient comfort during the treatment and minimized posttreatment soreness.

Basso and pike[31] stated that if the distal radius heals in a satisfactory position, functional prognosis tends to be good. Nevertheless, recovery may be delayed by the onset of soft tissue complications such as edema and pain, peritendinous adhesions, and algodystrophy, which require further physiotherapy. In this study, US treatment failed to change clinical outcomes since, although there were fewer physiotherapy referrals, this finding was not statistically significant.

Morishita et al. [32]reported no physiological effects on skin stretch temperature on the tissue; thus, the clinical implication of tissue cooling is not considered to be important. On the other hand, the ultrasound group showed significant influences, such as favorable results in the ROM and SP threshold during the 20-minute period after the intervention. This is clear evidence that ultrasound causes a direct mechanical effect on the skin and muscle due to a combined effect of thermal effects and mechanical effects in ultrasound.

This is consistent with **Kamal et al.** [33] who concluded that both Maitland's mobilization plus therapeutic ultrasound and closed kinetic chain exercises plus therapeutic ultrasound after Colles' fractures fixation improved patient hand function, grip strength, joint position sense, and range of motion. Both similar degrees of improvement, However Maitland's mobilization plus therapeutic ultrasound had more improvements than closed kinetic chain exercises in the wrist range of motion extension, radial deviation, and ulnar deviation.

5. CONCLUSION

It can be concluded that both Low-level laser therapy and therapeutic ultrasound after Colles' fractures fixation improved pain, patient hand function, grip strength, and range of motion. Both of similar degrees of improvement, However low-level laser therapy had more improvements than therapeutic ultrasound in the wrist pain and function.

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