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Post Operative Effect of Low Level Laser Therapy in Children with Supracondylar Humeral Fracture

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Abstract

Background: The most common fractured area in children is the supracondylar region and it is the most common operative elbow injuries in children.

Aim of Study: To investigate the post-operative effects of low level laser therapy (LLLT) on pain and range of motion (ROM) of affected elbow joint in children with supracondylar fracture.

Patients and Methods: Forty four children from both sexes with supracondylar humerus fracture underwent surgical intervention, their ages ranged from 4 to 10 years. They were participated in the study after two weeks from removing the pins and the cast. They were randomly assigned into two equal groups. Control group (A) received traditional exercises program only while study group (B) received LLLT and traditional exercises program. All participants in both groups were evaluated for pain level (pain intensity and pressure pain threshold PPT) and active ROM of their affected elbow joint before and after four weeks of the suggested treatment.

Results: There was no significant difference between both groups (control and study) pre-treatment ($p>0.05$). Comparison between both groups post treatment revealed a significant increase in PPT and elbow flexion and extension ROM, also there was a significant decrease in pain score of the study group compared with that of the control group ($p>0.001$).

Conclusions: Low level laser therapy combined with traditional exercise program can be used post-operative in children with supracondylar humerus fracture for decreasing pain level and increasing ROM of elbow joint.

Key Words: *Supracondylar humerus – Post-operative – LLLT.*

Introduction

SUPRACONDYLAR humeral fractures are representing up to two-thirds of pediatric elbow fractures **[1]**. There are two types of supracondylar fracture; extension-type fractures is the most common than flexion type and the distal fragment is extended compared to the proximal fragment **[2]**. Gartland's classification was modified by Wilkins and included a subdivision of type II injuries to include the presence or absence of a rotational deformity in classification of extension type **[3]**.

Surgical management is indicated for displaced Gartland II and Gartland III fractures. Urgent surgical management is indicated for patients with neurovascular compromise, compartment syndrome, and open fractures. For closed injuries, surgical management involves closed reduction and percutaneous pinning with K-wires **[2]**.

The term laser is an acronym that stands for light amplification by stimulated emission of radiation. The laser has interesting properties, like the high degree of spatial coherence allows a laser to be focused in a small spot or keep as a narrow beam for long distance **[4]**. Laser is a cost-effective and noninvasive approach in the field of physical therapy. Because of its unique properties, decrease pain (analgesic effect), low-power laser irradiation can alter cellular metabolism (bio-stimulating effect), improve the wound healing procedure (regenerative), decrease edema, and accelerate the inflammation process (anti-inflammatory effect). The LLLT has been employed as a treatment modality for a variety of conditions in medicine and dentistry including musculoskeletal pain syndrome, soft tissue injuries and ulcerations, and attenuating the complications of surgical procedures **[5,6]**.

Early physical therapy exercises for children after supracondylar humerus fracture are highly recommended for regaining the elbow function **[7]**.

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Despite the shortage concerning the post-operative effects of LLLT in children with supracondylar humerus fracture, there is growing evidence that LLLT has significant implications for pain level and ROM.

Therefore the purpose of this present study to investigate the post-operative effects of LLLT on pain level and ROM in children with supracondylar humerus fracture.

Patients and Methods

A total of Forty four children post supracondylar humerus fracture from both sexes underwent surgical intervention (closed reduction). They were recruited from Fayoum University Hospital to participate in the study according to this inclusion criteria; Children age was between 4 to 10 years old, after two weeks from removing the pins and the cast. Children clinically and medically stable. Exclusion Criteria; Children with associated upper limb nerve injury, Children with congenital or acquired skeletal deformities in the upper limbs and Children with neurological deficits such as convulsions, involuntary movements, receiving muscle relaxants.

This randomized control study was conducted at the outpatient clinic of Fayoum University Hospital from December 2019 to March of 2021, according to ethics approval from the Faculty of Physical Therapy, Cairo University, Egypt (no. P.T.REC/012/002329). All parents of children signed a consent form before starting the study procedures.

Randomization was performed using sealed envelopes. The investigator prepared the sealed envelopes which contained a piece of paper indicating whether each participant was in control or study group. Control group received a traditional exercise program and study group received the same exercise program combined with LLLT.

Materials for evaluation and treatment:

Material for evaluation:

- Wong-Baker FACES Scale was used to assess pain intensity.
- Pressure algometer (PA) was used to evaluate the PPT.
- Transparent Grading Sheet to locate painful points Fig. (1).
- 2- in-1 Digital Angle Ruler (Made in china) was used to assess the active ROM of elbow joint.

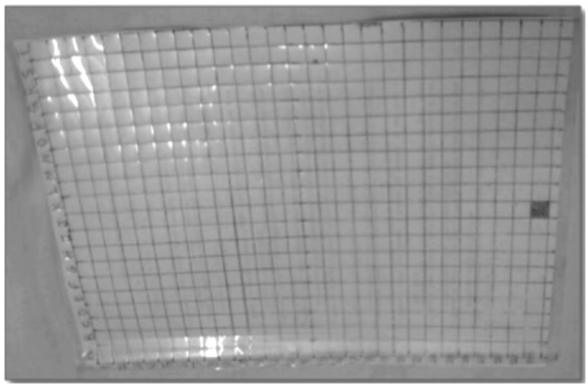

Fig. (1): Transparent grading sheet Adopted from Gomaa et al. [8].

Material for treatment:

Medilaser device (The class 3B Laser manufactured by Italy) was used to apply laser therapy for the study group.

Procedure:

All procedure for evaluation and treatment were explained to the children and their parents.

Procedure for evaluation:

The children were evaluated for pain level (pain intensity and PPT) and active ROM of the elbow joint before and after four weeks of the treatment.

Pain intensity assessment:

The intensity of the pain was measured using Wong-Baker FACES Pain Scale combined pictures and numbers for pain ratings. It can be used in children over the age of 3 and in adults. Each face represented a person who feels happy because he has no pain or sad because he has some or a lot of pain [9].

Pressure pain threshold assessment:

The tip of the algometer was positioned on the painful points. By pushing the algometer, the force applied to the point gradually increased. The child was not allowed to see the algometer display at any moment, and, was instructed that as soon as he/she experienced a painful sensation, to say “stop”, the algometer was immediately released and the force (in Kpa) was read from the display and recorded [10].

Transparent grading sheet:

For the assessment of painful points replacement consistency in the arm region, the A30 square was used as a reference mark over the lateral epicondyle while the first column (A30-A1) was fitted to the line extending to the shoulder region with the rest of the sheet one time anteriorly and the other posteriorly [8].

Range of motion assessment:

The patient was laying comfortable position; the 2- in-1 Digital Angle Ruler was applied on the lateral aspect of the elbow with the fulcrum on the humero-ulnar joint. The assessment of ROM was in form of flexion arc where the starting of ROM of flexion from extreme active extension point the patient can do it (zero point) to extreme active flexion point (reading measuring). The mean of the three successive reading was obtained [11].

Intervention:

Both groups (control and study) received traditional exercise program in the form of: ROM exercises for elbow joint, manual strengthening and stretching exercises (flexors and extensors) muscles of elbow joint. The study group (B) received LLLT in addition to the exercise program. Both groups received the treatment three times per week, for four weeks (12 sessions).

Exercise program:

Range of Motion Exercises: Ten repetitions of successive a flexion and extension were followed by relaxation [12]. Manual Strengthening Exercises: Ten repetitions were done in the form of isometric exercise for the flexors and extensors with hold; contraction for 6 seconds and relaxation for 6 seconds by using rubber matrix [12]. Isometric exercises were progressed by applying resistance in various positions or angles [13]. Stretching exercises were done in flexion or extension or in both directions according to the arc limitation from lying position [11]. The duration of the session was 45 minutes 3 times per week for four weeks.

Laser therapy:

The child received LLLT for three times per week, for four weeks (12 sessions) [14]. The painful point was selected by the (PA) and located by the grading sheet. The laser with MLA 8/800 laser probe the device wavelength 905nm, and power output of 100MW each (800mW total), and pulsed mode frequency of 10000Hz.

The diameter of each laser beam at the treatment point was $1cm^2$ for 1-minute (total time six minutes), exposure time giving energy of 6J per each laser beam (36J total).

Before applying the laser, the treated area was cleaned with alcohol, the physiotherapist gave information to all children that they were not to sense anything like warmness or any other sensation such as tingling or discomfort. The child and the therapist put on goggles during the application.

Statistical analysis:

Descriptive statistics and unpaired *t*-test were conducted for comparison of age between groups. Chi-squared was carried out for comparison of sex distribution between groups. Normal distribution of data was checked using the Shapiro-Wilk test for all variables. Levene's test for homogeneity of variances was conducted to test the homogeneity between groups. Unpaired *t*-test was conducted to compare the mean values of Wong-Baker FACES Pain Scale, PPT and elbow flexion and extension ROM between the group A and B. Paired *t*-test was conducted for comparison between pre and post treatment in each group. 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).

Results

Subject characteristics:

Table (1) showed the subject characteristics of the control group (A) and study group (B). There was no significant difference between groups in the mean age and sex distribution ($p>0.05$).

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

	Mean ± SD		*p*-value
	Group A	Group B	
Age (years)	6.86±1.2	6.9±1.3	0.9
Sex:			
Girls	9 (41%)	8 (36%)	0.76
Boys	13 (59%)	14 (64%)	

X: Mean. SD: Standard deviation. *p*-value, probability value.

Effect of treatment on Wong-Baker FACES Pain Scale, PPT and elbow flexion and extension ROM:

Within group comparison:

There was a significant increase in PPT and elbow ROM (flexion and extension) post treatment compared with that pre treatment in the group A and B ($p>0.001$). There was a significant decrease in pain score post treatment compared with that pre treatment in the group A and B ($p>0.001$), Tables (2,3).

Between groups comparison:

There was no significant difference between groups pre-treatment ($p>0.05$). Comparison between groups post treatment revealed a significant

increase in PPT and elbow ROM (flexion and extension). There was significant decrease in pain score of the group B compared with that of the group A (p>0.001), Tables (2,3).

Table (2): Mean values PPT and Wong-Baker FACES Pain Scale of the group A and B.

	Group A	Group B	MD	*t*-value	*p*-value
	Mean ± SD	Mean ± SD			
PPT (Kpa):					
Pre treatment	2.22±0.72	2.29±0.7	–0.07	–0.33	0.73
Post treatment	2.56±0.75	5.7±0.77	–3.14	–13.53	0.001
MD	–0.34	–3.41			
% of change	15.32	148.91			
t-value	–13.68	–65.85			
	p=0.001	*p*=0.001			
Pain score:					
Pre treatment	6.4±1.3	5.95±2.12	0.45	0.85	0.39
Post treatment	3.31±0.64	1.4±0.66	1.91	8.67	0.001
MD	3.09	4.55			
% of change	48.28	76.47			
t-value	12.16	12.46			
	p=0.001	*p*=0.001			

SD: Standard deviation. MD: Mean difference. *p*-value: Probability value.

Table (3): Mean values elbow flexion and extension ROM of the group A and B.

	Group A	Group B	MD	*t*-value	*p*-value
	Mean ± SD	Mean ± SD			
Flexion ROM (degrees):					
Pre treatment	93.95±9.77	91.43±7.73	2.52	0.94	0.34
Post treatment	109.45±8.53	120.26±7.67	–10.81	–4.42	0.001
MD	–15.5	–28.83			
% of change	16.5	31.53			
t-value	–17.81	–32.37			
	p=0.001	*p*=0.001			
Extension ROM (degrees):					
Pre treatment	29.15±6.94	31.03±6.16	–1.88	–0.95	0.35
Post treatment	18.34±5.4	6.06±3.15	12.28	9.2	0.001
MD	10.81	24.97			
% of change	37.08	80.47			
t-value	14.07	31.25			
	p=0.001	*p*=0.001			

SD: Standard deviation. MD: Mean difference. *p*-value: Probability value.

Discussion

The supracondylar humerus fracture is a common fracture in children [15]. Due to the complexity of the anatomy and biomechanics of the elbow joint, it is inclined to stiffness [16]. Stiffness of the elbow joint is a possible complication post supracondylar humerus fracture and postoperative immobilization [17].

Low level laser therapy is used by physiotherapists to treat a wide variety of acute and chronic musculoskeletal aches and pains. It is also widely used in sports-medicine and rehabilitation clinics to reduce swelling and hematoma, relieve pain, improve mobility and treat acute soft-tissue injuries. It is applied to various points on the body acupuncture points, muscle-painful points [18].

The purpose of the study was to investigate the post-operative effects of LLLT on pain level (pain intensity and PPT) and ROM of the affected elbow in children with supracondylar humerus fracture.

The mean values of ages (mean ± standard deviation) of the control group and study group were (6.91 ± 1.31) and (6.9± 1.3) respectively. Comparing means values of the two groups (control

and study) revealed non-significant differences (p=0.99). The distribution of girls and boys in the control group was 41% and 59%. While in the study group they were 36% and 64% respectively. There was no significant difference in age and sex distribution between both groups.

The findings of this study showed that LLLT had significant improvement in all measured variables (pain level and ROM) when comparing post treatment measures between both groups (control and study).

Regarding the results of the study group; The effect of LLLT in decreasing pain level and consequently increase ROM may be attributed to it's anti-inflammatory action via influence in modulating inflammatory mediators and inflammatory cells (macrophages and neutrophils) **[19]**. It also has an analgesic effect which leads to reduce pain level of the elbow and as result in improves ROM of the affected elbow **[20]**.

The laser of 905 nm was used in this study; it had beneficial clinical effects according to Huang et al. **[21]** who stated that the exposure of tissues and cells to infrared or red light (600-1100nm) leads to stimulation of cellular functions.

In this study, the frequency was used 36 J/cm ^{2} which was effective according to most of the reported literature. The frequencies of LLLT should be ranged from 0.04 to 50 J/cm ^{2} to be effective in treatment **[22,23]**.

Decreasing pain in this study comes in agreement with Baktir et al. **[24]** who used LLLT in treating the patient with lateral epicondylitis.

The laser was applied by Okuni et al. **[25]** on patients with chronic pain of the elbow, wrist, and fingers. The result of their study revealed that it was an effective modality for pain reduction which was supported the results of this study.

There was a significant improvement in PPT in this study; it was confirmed by Rayegani et al. **[26]** who stated that the LLLT was the preferred treatment for improving the PPT in comparison with other modalities.

The use of LLLT post forearm fracture in children has an effect on pain reduction and improves ROM of wrist joint in children **[14]** and that comes in agreement with the results of this study.

After Colles' fractures fixation, the use of LLLT had significant effects on pain, patient function, and ROM **[27]** which supported the result this study.

In contrast with the results of this study, Kobordo **[28]** concluded that LLLT was ineffective in terms of treating pain.

Application of LLLT before exercise program has a positive effect as reported by De Marchi et al. **[29]** who suggested that phototherapy before exercise seems not only to improve muscle performance but also to prevent injuries due to muscle fatigue and improve post-exercise recovery.

Further studies are recommended to investigate the effect of laser on others types of fractures in children.

Conclusion: Low level laser therapy with traditional exercise program post-operative supracondylar humerus fracture in children has been effective in improving pain level and ROM.

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تأثير الليزر منخفض الشدة فى الأطفال بعد تدخل جراحى لكسر أعلى لقمة الكوع العظمية

كسر أعلى لقمة الكوع العظيمة يعتبر أكثر الكسور شيوعاً فى الأطفال ومن الأكثر الكسور التى تحتاج إلى تدخل جراحى.

الهدف من هذه الدراسة: معرفة تأثير الليزر منخفض الشدة على الألم والنطاق الحركى فى الأطفال بعد التدخل الجراحى لكسر أعلى لقمة الكوع العظمية. تم تقسيم ٤٤ طفل من الجنسين بعد تدخل جراحى لكسر أعلى لقمة الكوع العظمية إلى مجموعتان متساويتان. حصلت مجموعة التحكم على تمرينات علاجية فقط بينما المجموعة الدراسة على الليزر منخفض الشدة بالاضافة إلى التمارين العلاجية.

النتائج: كان لا يوجد فروق ذات دلالة إحصائية بين المجموعتين قبل بداية العلاج. بعد تلقى العلاج توجد فروق ذات دلالة إحصائية فى التحسن فى مجموعة الدراسة مقابل مجموعة التحكم فى تحسن مستوى الألم والنطاق الحركى.

ننصح باستخدام الليزر منخفض الشدة بالاضافة إلى التمارين العلاجية بعد تدخل الجراحى لكسر أعلى لقمة الكوع العظمية لتأثيره الجيد على تحسن مستوى الألم والنطاق الحركى.