Irradiation Effect of Low-Level Laser on Functional Outcome in Children with Bell's Palsy

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ABSTRACT

Background: *There are many evidences that low-level laser therapy (LLLT) may stimulate nerve regeneration. Objective: The aim of the study was to evaluate the effectiveness of LLLT in enhancing functional recovery in children with Bell's palsy (BP).* ***Subjects:*** *Twenty patients with BP of axonotemetic type were selected (thirteen males and seven females). They ranged in age between 12 and 15 years old. They were randomly divided into two groups of equal number, study and control.* ***Methods:*** *The severity of BP was assessed by "House-Brackmann grading scale". Also, facial symmetry was measured at rest by using tape measurement. Both groups received physical therapy program. Additionally, the control group received placebo laser while the study group received continuous infrared (IR) laser 830 nm, 100mw with dose of 6.0 J/cm^2, at five points overlying the main facial trunk and four motor branches of the facial nerve. The study continued for 4 week, 3 times / week, every session continued for 60 minutes.* ***Results:*** *The results revealed no significant difference between the study and the control groups after treatment, neither in House-Brackmann grades or in facial symmetry measurement.* ***Conclusion:*** *It can be concluded that infrared laser, with the parameters used in the current study, was not effective in improving functional outcome in BP.*

Keywords: *House-Brackmann grading scale, infrared laser, Bell's palsy.*

INTRODUCTION

Peripheral injury of the facial nerve is a frequent disorder. It is a stressful situation for the patient and is functionally hazardous for the cornea. The idiopathic facial paralysis or Bell's palsy (BP) is the most common type[1]. It is an acute, lower motor neuron paralysis of the face, usually unilateral, related to inflammation and swelling of facial nerve within the facial canal or at the stylomastoid foramen[2].The anatomy of the facial nerve is rather complex for a cranial nerve, with a long intracranial course, in which the nerve takes three bends or genu[3].

The exact causes of BP are unknown. However, it is thought that viral infection of the nerve is the most likely cause. Herpes simplex virus is considered the most likely viral cause[4,5,6]. Moreover, the pathophysiology of BP remains unclear and the treatment also remains controversial[1].

Patients with facial nerve disorders are often devastated due to the emotional and psychological impact of facial disfiguration as well as the subsequent physical limitations and difficulties associated with speaking, drinking, eating, and facial expression. Socialization and community participation is extraordinarily limited and difficult for many of these patients[7].

Studies on BP are difficult to evaluate, bearing in mind the high spontaneous remission rate. Moreover, there are no established guidelines for the treatment. The treatment strategy for BP is to accelerate recovery, to prevent further worsening of facial palsy in patients who are only mildly affected, and to avoid sequelae, such as synkinesis, contracture, and facial asymmetry, in more severe cases. Acceleration of damaged nerve regeneration is one important area of research. Low level laser therapy (LLLT) is an electrical modality that is used widely in the medical field. Individuals and families use laser instead of medication for variety of conditions ranging from headache, low back pain to insomnia. However, the swelling and the neuritis in the bony facial canal is believed to be influenced by LLLT in patients with facial palsy. This intra-bony region of the nerve is the major target of laser therapy in this indication. The suspected association with herpes virus also supports the use of laser therapy in such cases[8,9].

Aim of the study

The aim of the study was to evaluate the effectiveness of LLLT on the functional recovery in children with BP.

SUBJECTS, MATERIALS AND METHODS

Subjects:

Twenty patients with BP (thirteen males and seven females) were selected from King Fahd Armed Forces Hospital in Jeddah. Inclusion criteria: The patients' age ranged from 12 to 15 years (mean = 13 ± 1.1), the duration of illness ranged from 4 to 6 weeks, and the facial nerve injury was of axonotemetic type confirmed by electro-physiological examination. Exclusion criteria: Facial problems other than BP as wounds, burns, skin allergy conditions or diabetes mellitus. Patients were randomly assigned into two groups of equal number, study and control.

Instrumentation:

Laser instrument:

Enraf Nonius Endolaser, model 476, made in Argentina, AlGaAs diode laser with wavelength 760/830 nm. The beam delivery system is hand held probe, continuous/ pulsed, the output power ranges for 25-100 mw, and the dose ranges from 0.01-9.99 Joules. It has two accessory goggles for eye protection (Fig. 1).

Fig. (1): Laser instrument.

House-Brackmann grading scale: It was used to assess the severity of BP. It categorizes BP from normal (grade one) to total palsy (grade six) (table 1).

Table (1): House-Brackmann grading scale4.

GRADE	DESCRIPTION
1 (Normal)	Normal facial function in all nerve branches
2 (Slight)	Gross: Slight weakness in close inspection and slight synkinesis. At rest: Normal tone and symmetry. Motion: - Forehead: Good to moderate movement. - Eye: Complete closure with minimum effort. - Mouth: Slight asymmetry.
3 (Moderate)	Gross: Obvious but not disfiguring facial asymmetry. Synkinesis is noticeable but not severe. There may have hemi-facial spasm or contracture. At rest: Normal tone and symmetry. Motion: - Forehead: Slight to moderate movement. - Eye: Complete closure with effort. - Mouth: Slight weakness with maximum effort.
4 (Moderately severe)	Gross: Asymmetry is disfiguring and / or obvious facial weakness. At rest: Normal tone and symmetry. Motion: - Mouth: Asymmetrical with maximal effort.
5 (Severe)	Gross: Only slight, barely noticeable movement. At rest: Asymmetrical facial appearance. Motion: - Forehead: No movement. - Eye: Incomplete closure. - Mouth: Slight movement.
6 Total	No facial function.

Methods:

Evaluation:

All patients were assessed before and after treatment by the House-Brackmann grading scale of facial palsy. Facial symmetry was measured at rest by tape measurement recording the distances from the ear tragus to the angle of the mouth. It was carried out for both sides of the face (affected and unaffected) in the study and control groups.

Treatment:

Control group:

Patients received a physical therapy program which consisted of manual massage, exercising of the facial muscle performed in lying position at first, then in sitting. The patient was asked to look surprise then frown, close eyes firmly then open wide, smile, grin, say "o, e ", whistle and blow. The patient received assistance at first then progressed to resistance. A mirror was useful to enable the patient to observe the muscle activity and compare between both sides of the face. The patient was instructed to follow exercise program, twice a day, ten repetitions for each exercise with rest in between and in front of the mirror[10]. In addition, they received placebo laser irradiation.

Study group:

Patients received the previously mentioned physical therapy program. In addition, they received LLLT. Before laser application, patient was prepared as following: Patients were instructed to remove facial hair before laser treatment. Then the area of treatment was cleaned well with alcohol. He/she assumed a comfortable position and was asked to wear the goggles.

Laser was applied on the main nerve trunk which lies 18.8 mm caudal to the tragus of the ear where it lies 23.6 mm deep to skin surface[11]. In addition, four motor branches of the facial nerve (temporal, zygomatic, buccal and mandibular) were also irradiated about two centimeters from the nerve trunk in the direction of each branch. Laser parameters were continuous wavelength 830 nm, 100 mw, with dose of 6.0 J/cm^2 for 4 minutes for each point[12]. The treatment was continued for four weeks, three times / week; every session continued for 60 min.

Statistical analysis:

Data was presented as means and standard deviations. Paired and unpaired t-tests were used to analyze parametric data. Mann Whitney and Wilcoxon tests were used to analyze non-parametric data. The p-value was 0.05.

RESULTS

House-Brackmann grading scale:

There was no significant difference between study and control groups regarding House-Brackmann grade mean values neither before (mean = 5.04 ± 0.21 and 5.08 ± 0.13, respectively) nor after treatment (mean = 4.87 ± 0.37 and 5 ± 0.14, respectively), (p = 0.7 and 0.8, respectively). Also, the results revealed no significant difference after treatment compared to that before treatment in both the study and control groups (p = 0.4 and 0.1 respectively) (table 2 and fig. 2).

Table (2): Comparison between study and control groups as regard House-Brackmann grade mean values before and after treatment.

House-Brackmann grades	Study group Mean ± SD	Control group Mean ± SD	P
Pre	5.04 ± 0.21	5.08 ± 0.13	0.7
Post	4.87 ± 0.37	5 ± 0.14	0.8
P	0.4	0.1	

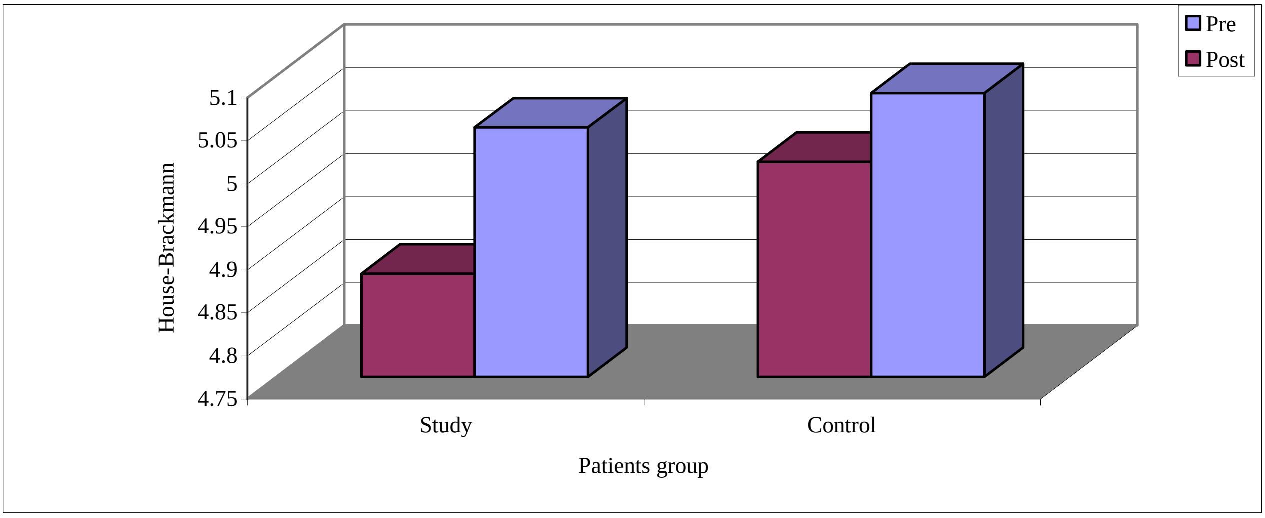

Fig. (2): Mean values of House-Brackmann grades before and after treatment in the study and control groups.

Facial symmetry:

The results revealed non significant difference between the study and control groups regarding facial symmetry measurement mean values neither before (mean = 9.6 ± 0.5 and 10.6 ± 0.65.respectively) nor after intervention (9.4±0.55and 10.3±0.6, respectively) (P = 0.18 and 0.12, respectively). On the contrary, there was a significant decrease of measurement mean values within the study and control groups after treatment, compared to that before treatment (P = 0.009 and 0.05, respectively) (table 3 and fig. 3).

Table (3): Comparison between study and control groups as regard facial symmetry measurement before and after treatment.

House- Brackmann grading scale	Study group Mean ± SD	Control group Mean ± SD	P
Pre	9.6 ± 0.5	10.6 ± 0.65	0.18
Post	9.4 ± 0.55	10.3 ± 0.6	0.12
P	0.009 **	0.05 *	

* Significant
** Highly significant

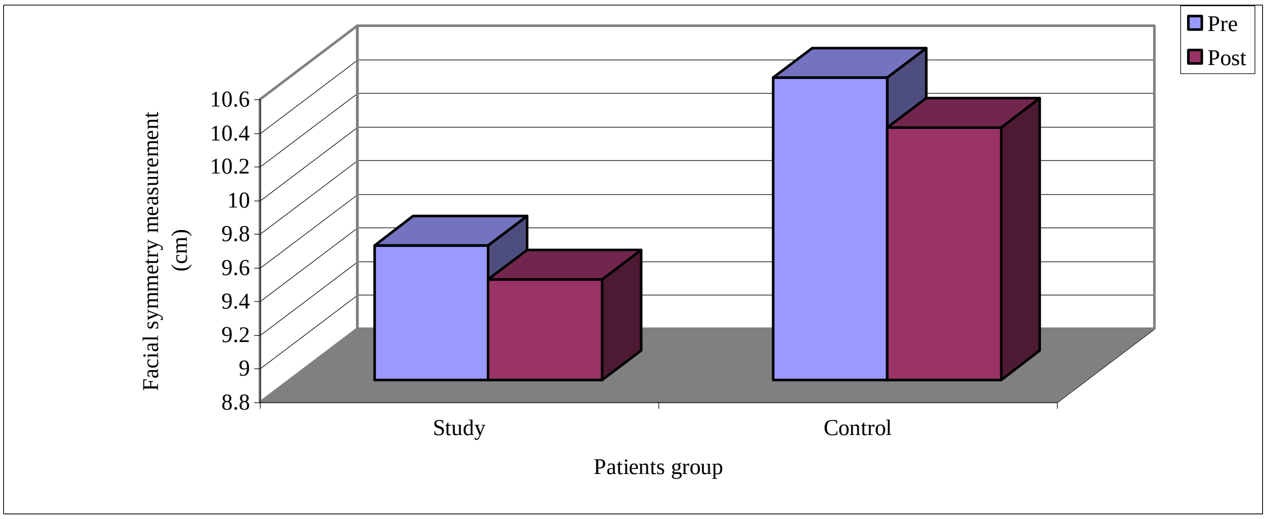

Fig. (3): Mean values of facial symmetry measurement before and after treatment in the study and control groups.

The results also showed non significant difference in facial symmetry measurement between normal and affected sides of the face in the study group. The mean values of facial symmetry measurement of the affected and unaffected sides were (9.4 ± 0.55 and 9.2 ± 0.55, respectively) after treatment (P = 0.6) (table 3 and fig. 4).

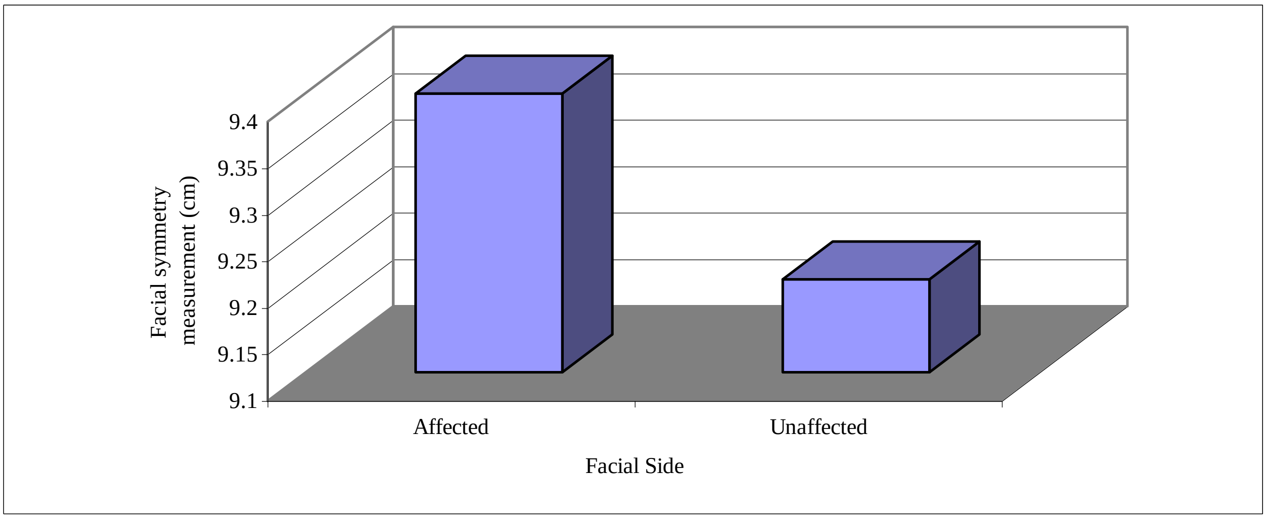

Fig. (4): Mean values of facial symmetry measurement of the affected and unaffected sides after treatment in the study group.

DISCUSSION

Untreated BP leaves some patients with major facial dysfunctions and a reduced quality of life. The current study aimed at investigating the effect of IR laser on functional recovery in children with BP. Many evidences have shown that peripheral nerves regeneration may be accelerated by physical agents, such as electric power, magnetic fields, and ultrasound. Laser therapy has also been studied regarding a potential positive role in this particular area, with first investigations focusing on changes in nervous stimulus passage, with an electrophysiological demonstration of a reduced latency time, and increased conduction velocity in normal nerves in human beings[13,14].

The results of the current study revealed no significant difference between the study and control groups after laser irradiation regarding functional recovery according to House- Brackmann scale grades and facial symmetry measurements. On the other hand, a significant difference was found within the study and the control groups. This may be attributed to the effect of massage as well as the facial exercises that regained the face to normal or near normal alignment.

In accordance to the findings of the present work, Saitkulov et al[15] studied the effect of IR laser irradiation on regeneration of nerve fibers in rat sciatic nerve. Starting from the first day after nerve crushing, the projection of proximal portion of the nerve was transcutaneously stimulated by 890 nm laser irradiation with total dose of 42 J/cm^2. On day 30 after crushing, there were no significant differences in the number of myelinated fibers and mass of regenerating soleus muscle in the test and control groups.

Furthermore, Chen et al.,[16] studied the effect of low-power pulsed laser irradiation on the regeneration of a 10-mm gap of rat sciatic nerve created between the proximal and distal nerve stumps. After eight weeks of recovery, pulsed laser-irradiated groups had significantly lower success rate of regeneration compared to sham-irradiated controls. They reported that deleterious effects have been demonstrated, such as lower regeneration percent rate translated by a less mature ultra structural organization, with smaller cross-sectional areas and smaller number of myelinated axons in irradiated nerves. They concluded that irradiation with pulsed laser may have suppressive effects on peripheral nerves regeneration.

On the contrary, Anders et al[17] examined quantitatively if transcutaneous LLL irradiation can affect the regeneration of the rat facial nerve. The facial nerve was crushed unilaterally in rats and transcutaneously irradiated daily with a laser directed at the area of the crush injury and began on the day of the injury and was continued daily for 7, 8, or 9 days. Preliminary experiments determined the most effective wavelength, laser power, length of irradiation, and treatment schedule. The most effective laser parameters for the low power treatment included daily irradiation with a helium-neon (HeNe) or argon pumped tunable dye laser a wavelength of 633 nm, with a power of 8.5 mW for 90 minutes (45.9 J, 162.4 J/cm2). The number of horseradish peroxidase (HRP) labeled neurons in the facial motor nucleus were used as an assay of the degree of regeneration. There was a statistically significant difference between the control and irradiated rats on day 9 postcrush. These data indicate that transcutaneous LLL irradiation with the laser type and parameters involved in this study increased the rate of regeneration of rat facial nerve following crush injury. It is evident that the difference between the previous results and the findings of the current work can be explained by the different laser type and parameters used.

Further study was carried out by Khullar et al[18] who studied the effects of laser therapy on re-innervation of sciatic nerve after GaAlAs laser, 6J, 830 nm daily for a period of 28 days. They found improved functional recovery in the nerve indicated by SFI. They concluded that laser accelerated motor nerve re-innervation assessed by return of motor function subsequent to a standardized axonotmesis injury in the rat sciatic nerve. It can be noticed that the photo-chemical effects of LLL is greatly dose-dependent.

Moreover, Endo et al.,[19] tested IR laser irradiation in controlled crush injury of sciatic nerve in rats for 10 consecutive days beginning on the first postoperative day. Results were evaluated at three weeks postoperatively by measuring the sciatic functional index (SFI) at weekly intervals and the total number of nerve fibers and nerve fiber density of the sciatic nerve at three weeks. The SFI progressively improved for both irradiated and control nerves. Nerve fiber density also increased significantly in the irradiated nerves. They concluded that LLLT accelerates nerve regeneration. The difference between these results and the findings of the current study may be attributed to laser wave length they used being 904 nm in addition to daily irradiation.

Recently, Zhang et al[20] conducted a study to discuss the effects of 660-nm GaAlAs LLL irradiation on neural regeneration after acellular nerve allograft repair of the sciatic nerve gap in rats. They found significant increased nerve conduction velocity, restoration rate of tibialis anterior wet muscle weight and myelinated nerve number. They concluded that LLL therapy increased the rate of regeneration and target reinnervation after repair of the sciatic nerve. Consequently, LLL irradiation may be a useful, noninvasive adjunct for promoting nerve regeneration in surgically induced defects repaired nerves. Contrary to the results of the current study, their findings may be attributed to the difference in wave length (660 nm). Moreover, they applied laser for the sciatic nerve that may be more responsive to LLL than the facial one regarding the anatomical pathway and the depth of penetration of laser.

There are several suggested mechanisms for acceleration of nerve regeneration. Tuner and Hode[8] reported that LLLT helps the cell to produce ATP- the basic energy packer of cells- by up to 150% via affecting the mitochondria. This extra energy helps cells to promote healing. Laser light activates enzymes within the cells, causing them to produce proteins and rebuild themselves. Photons affected the cell membrane and normalize its polarity. This balanced polarity helps the cell to absorb the nutrient it needs and wastes more easily toxins from the cells.

Conclusion

Despite of the current easy availability of therapeutic laser and its trend to be routinely employed in injuries of a number of tissues, its effects on peripheral nerve regeneration are still controversial and need to be precisely determined before its application. According to the findings of the present research, it can be concluded that LL laser, with the parameters used in the current study, was not effective in improving functional outcome in BP.

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الملخص العربي

تأثير أشعة الليزرِ ذو المستويِ المنخفضِ على النتيجةِ الوظائفية في الأطفالِ المصابونِ بشللِ بيل

الخلفية : عندما يصاب الشخص بشلل نصفي للوجه (شلل بيل) فإن استعادة الشكل الطبيعي ووظائف الوجه قد تستغرق مدة طويلة أو يحدث شفاء بشكل نسبي . **الهدف :** الهدف من هذه الدراسة هو تقييم فعالية العلاج بأشعة الليزر ذو المستوى المنخفض في الأطفال الذين يعانون من شلل بيل . الأشخاص : تم اختيار عشرين طفلاً مصابون بشلل بيل تراوحت أعمارهم من ١٢ إلى ١٥ عاما و قُسموا عشوائيا إلى مجموعتين متساويتين (مجموعة دراسة و مجموعة ضابطة) . **الطريقة :** تم تقييم شدة إصابة العصب باستخدام مقياس هاوس براكمان وكذلك مدى الاختلاف في الشكل الخارجي للوجه بالقياس اليدوي باستخدام شريط القياس (المتر) ، عولجت المجموعة الضابطة ببرنامج علاج طبيعي بالإضافة إلى أشعة الليزر الكاذبة بينما تلقت مجموعة الدراسة نفس البرنامج بالإضافة إلى العلاج بالليزر عن طريق تعريض عصب الوجه لأشعة الليزر تحت الحمراء المستمرة في بعض النقاط (مركز العصب السابع وبداية كل فرع من الفروع الحركية للعصب) بواقع أربع دقائق لكل نقطة بطول موجة ٨٣٠ نانو متر و قوة ١٠٠ ملي وات (٦ چول/سم٢) . إستمر العلاج لمدة ٤ أسابيع بمعدل ٣ جلسات أسبوعياً وكانت مدة الجلسة الواحدة ستون دقيقة . **النتائج :** أوضحت النتائج عدم وجود فروق ذات دلالة إحصائية بين المجموعتين في نتائج مقياس هاوس براكمان وتماثل نصفي الوجه . **الخلاصة :** يُستنتج من نتائج هذا البحث أن الليزر، بالمواصفات التي أُستخدمت في هذا البحث ، لم يكن له تأثير فعال في علاج الأطفالِ المصابونِ بشللِ بيل .

الكلمات الدالة : مقياس هاوس براكمان - أشعة الليزر تحت الحمراء - شلل بيل .