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# The Use of Phototherapy for Bell's Palsy

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## Abstract

Various methods have been used to treat Bell's palsy, ranging from physical therapy, medications, to decompression surgery. The standard treatment is currently a prescription of corticosteroids with antiviral agents. All these medical approaches yield mixed results, and there is a need for additional investigation on treatment options. Recent studies have shown that facial palsy responds positively to phototherapy treatment, in particular the low-energy infrared laser. In the present report, we attempt to review the current clinical application of phototherapy, representing a conservative and safe medical approach in the treatment of Bell's palsy. A literature review was performed. The results of the included studies suggested that low-level laser therapy (LLLT) is a significant treatment modality for patients recovering from Bell's palsy. However, the risk of bias of the included studies was relatively high, and further research could change the estimate of effect of this treatment option. In conclusion, there is currently a moderate evidence to support the effectiveness of low-level laser therapy in the treatment of Bell's palsy. Further randomized double-blind placebo-controlled trials and high-quality studies are needed to determine with certainty the benefits of this treatment option for Bell's palsy.

**Keywords:** low-level laser therapy, infrared laser, LED, facial palsy, Bell's palsy

## 1. Introduction

Bell's palsy is an idiopathic lesion to the facial nerve, also known as cranial nerve VII. It is responsible for the control of the muscles of the facial mimic. It is the most common unilateral facial paralysis [1] and is diagnosed by excluding the other possible etiologies including congenital, neoplastic, tumors, diabetes mellitus, polyneuropathy, iatrogenic, infection, trauma, and other inflammatory causes [2, 3]. Bell's palsy is characterized by a rapid onset over several hours and partial or complete unilateral paralysis of the facial nerve without other neurologic complaints [4, 5].

This paralysis is related to an inflammation of the facial nerve near the stylomastoid foramen. The main sign for Bell's palsy is a distorted facial expression, but patients can experience other symptoms (e.g., taste loss, pain around the ear, or hearing problems [2, 6]).

With an incidence oscillating between 11 and 40 cases per 100,000 inhabitants per year [7–9], Bell's palsy represents a relatively common disease that raises important psychological issues because it involves the ability to express emotions, and a diminished facial expression interferes with social interactions [10]. Indeed, the face represents psychologically the most important part of the body and an important component of self-concept [11].



**Figure 1.**  
*Patient receiving low-level laser therapy treatment for Bell's palsy.*

Concerning the prognosis, some studies show that complete recovery from Bell's palsy occurs in 70–85% of affected patients, whereas the remaining 15–30% demonstrate incomplete recovery with symptoms such as weakness, hyperkinesia, and synkinetic contracture [12–14]. As for its treatment, the standard approach is currently a prescription of corticosteroids with antiviral agents, but there are other treatment options available such as surgery and physical therapy. The use of corticosteroids has shown opposing results in different studies. Some clinical trials showed a significant benefit from treating Bell's palsy with corticosteroids [14–17]. Devriese et al. [18], however, demonstrated that its use has no significant effect on the outcome of this condition. As reported by the most reliable studies, antivirals have not been proved to be superior to placebo [19], surgery is disputed [17], and there are only a few controlled clinical trials for the efficacy of physical therapy, massage, and facial exercises.

In this context, there is a need for additional investigation on other treatment options. Recent studies have shown that facial palsy responds positively to phototherapy treatment, in particular the low-energy infrared laser. In the present report, we attempt to review the current clinical application of phototherapy, representing a conservative and safe medical approach in the treatment of Bell's palsy (**Figure 1**).

## **2. Low-level laser therapy and its biological effects**

Lasers (light amplification by stimulated emission of radiation) were originally described in the 1960s by Theodore Maiman [20]. Seven years later Mester et al. started to investigate on low-level laser [21] and its therapeutic effects.

Low-level laser therapy involves exposing cells or tissue to low levels of red and near-infrared light, to promote tissue regeneration, reduce inflammation, and relieve pain. It is referred to as “low level” because the energy densities are low when compared to other forms of laser therapy that are used for ablation, cutting, and thermally coagulating tissue [22]. LLLT is also known as “cold laser” therapy as the power densities used are lower than those needed to produce heating of tissue.

LLLT has a photochemical effect which means the light is absorbed and causes a biochemical change [23], but the precise mechanism is not well established. From observation, it appears that LLLT has several effects at the tissue, cellular, and even molecular levels. Furthermore, different applications may change its specific modes of action. At the cellular level, existing evidence suggests that LLLT acts on the mitochondria [24], stimulates the production of adenosine triphosphate (ATP) [25], modulates the reactive oxygen species (ROS), and which then activates the transcription factors [26].

These transcription factors, in turn, induce protein synthesis that generates further effects subsequently. These effects include increase of cell propagation and migration, modulation in cytokines levels, inflammatory mediators and growth factors, and augmented tissue oxygenation [27].

The mechanisms described above only partly explain the overall effects of LLLT. This therapy has also shown to cause vasodilation, probably related to photodissociation of nitric oxide (NO) [28], which is a powerful vasodilator. This leads to better oxygenation of the targeted cells and also allows increased traffic of immune cells into tissues. Both mechanisms are linked to a faster healing.

### **3. Anatomy, mechanism, and etiology of Bell's palsy**

In order to understand the pathophysiology of Bell's palsy and deduce the hypothetical benefits of LLLT on this condition, it is essential to know the course and function of the facial nerve (CN VII).

#### **3.1 Anatomy**

CN VII is responsible for the motor innervation of the facial muscles, stapedius, and posterior belly of the digastric muscles [29]. The facial nerve enters the temporal bone at the internal acoustic meatus and then continues along the fallopian canal before exiting through the stylomastoid foramen. It is to note that the thinnest portion of the fallopian canal is located in the internal auditory canal, at its lateral end [29].

#### **3.2 Mechanism**

The mechanism of Bell's palsy is thought to be an inflammation of CN VII with a related compression in the narrow portion of the fallopian canal [30, 31]. This inflammation causes temporary loss of motor and sensory function and potentially also leads to nerve degeneration in the longer term [30].

#### **3.3 Etiology**

The cause of this neuropathy has not been firmly established, and several theories have been proposed. One describes Bell's palsy as a mononeuritic variant of Guillain-Barre syndrome [32–34], both pathologies representing an inflammatory demyelinating neuritis.

Recent studies have linked Bell's palsy to the reactivation of latent herpes virus in the geniculate ganglia, with migration to CN VII [35, 36]. Herpes zoster virus

(HZV) and herpes simplex virus 1 (HSV-1) could be related agents, with HZV thought to be more harmful as it disseminates over the nerve via satellite cells [35]. Concerning HSV-1, its DNA has even been extracted from the endoneural fluid of CN VII during a study from a patient suffering from acute Bell's palsy [37]. Other recent studies have also shown evidence for the theory of inflammation caused by herpes simplex virus, related to nerve compression and paralysis of the face [14, 36, 38].

A correlation was also found between Bell's palsy and the inactivated intranasal influenza vaccine, with a risk multiplied by 19 for patients having received the flu vaccine as compared to that of control groups without vaccination [39]. It is of note that the peak incidence of the condition was at 31–60 days after vaccination, suggesting that an autoimmune disorder or reactivation of HSV rather than a direct toxic effect from the vaccine is operative [40]. This vaccine is no longer in use.

Other infectious etiologies that have been documented include Epstein-Barr virus, rubella, mumps, influenza, Coxsackievirus, adenovirus, cytomegalovirus, and rickettsia, with the latter being a rare cause [41, 42].

There are also noninfectious causes that have been suggested, including familial origin, with some 4–8% of patients reporting to have family history of the pathology [43], ischemia associated to atherosclerosis causing edema of the facial nerve [44–46], and autoimmune processes such as Hashimoto's encephalopathy [47, 48].

## **4. Effectiveness of LLLT for Bell's palsy**

A literature review was performed to assess the effectiveness of LLLT for the treatment of Bell's palsy.

### **4.1 Method**

#### *4.1.1 Search strategy*

An initial electronic search was constructed to identify English language studies that examined LLLT for Bell's palsy. PubMed, EMBASE, PEDro, and J-Stage databases were searched from inception to July 2018. The titles and abstracts have been screened in order to identify the relevant studies. Full-text copies of these studies were retrieved and considered for inclusion in this review.

#### *4.1.2 Selection criteria*

Studies were included if they were randomized and nonrandomized controlled trials evaluating the effectiveness of LLLT compared to other common interventions or compared to a placebo/sham control in the treatment of Bell's palsy. Studies were excluded if they are published in languages other than English.

#### *4.1.3 Assessment of risk of bias for included studies*

The risk of bias was assessed using the Cochrane Bias Methods Group's criteria for randomized controlled trials [49] and the Effective Practice and Organization of Care's criteria for nonrandomized trials [50].

#### 4.1.4 Data analysis

The data was extracted and reported qualitatively only, due to the heterogeneity of the studies.

#### 4.1.5 Grading the strength of evidence

Strength of evidence was assessed using the GRADE Working Group grades of evidence [51] as follows:

- High quality: further research is very unlikely to change our confidence in the estimate of effect.
- Moderate quality: further research is likely to have an important impact on our confidence in the estimate of effect and may change the estimate.
- Low quality: further research is very likely to have an important impact on our confidence in the estimate of effect and is likely to change the estimate.

## 4.2 Results

### 4.2.1 Study selection

The electronic search and screening of titles and abstracts identified nine potentially relevant studies; they were retrieved and considered for inclusion [52–60]. Of these studies, five satisfied the eligibility criteria and were included in the review [52–56].

### 4.2.2 Study characteristics

**Table 1** displays the included studies' characteristics. Three studies were randomized controlled trials, and the other two were nonrandomized controlled trials. All studies compared LLLT to other common treatments (group control). Only one study [52] included a sham/placebo laser associated to a common treatment, and LLLT associated to the same treatment was compared. Two studies compared the effectiveness of LLLT and facial exercise [52, 54]. Two studies compared LLLT with corticosteroids [53, 56]. One assessed the effectiveness of LLLT in comparison to stellate ganglion block (local anesthetic injection in the sympathetic nerve tissue of the neck). Treatments varied substantially in their dosage and length, from 30 days [55] to 8.9 weeks [56]. The study samples comprised of 51, 50, 46, 52, and 24 subjects. Finally, the outcome measurement procedures consisted in different recognized scales for the assessment of facial palsy severity. One study, however [53] also included electroneurography as one of the outcome measures.

### 4.2.3 Risk of bias assessment

**Table 2** displays the risk of bias assessment across the included studies. One randomized controlled trial (RCT) [52] was found to be overall at low risk of bias. With that exception, all other studies were at high risk of performance bias, as no sham/placebo laser procedure was established, and therefore there was no blinding of participants. The two nonrandomized controlled trials [55, 56] had high risk of selection bias as opposed to the randomized controlled trials that appeared to be

Study	Design	Study sample	Intervention	Outcome measures	Follow-up period	Outcome
Alayat et al. [52]	Randomized controlled trial	51 subjects with unilateral Bell's palsy mean age = 43 ± 9.8 years	1. HILT + facial massage and exercise 2. LLLT + facial massage and exercise 3. Facial massage and exercise	Facial disability scale, House-Brackmann scale	6 weeks	HILT and LLLT + facial massage and exercises, respectively, more effective than facial massage and exercises with sham laser
Kudoh et al. [53]	Randomized controlled trial	50 subjects with Bell's palsy age ranged from 35 to 60 years	1. LLLT + corticosteroids 2. Corticosteroids	Yanagihara evaluation scale, electroneurography (ENoG)	3 months	LLLT + corticosteroids more effective than corticosteroids alone
Ordahan et al. [54]	Randomized controlled trial	46 subjects with unilateral Bell's palsy mean age 41 ± 9.7 years	1. LLLT + facial exercise 2. Facial exercise	Facial disability index	6 weeks	LLLT + facial exercise more effective than facial exercise alone
Murakami et al. [55]	Nonrandomized controlled trial	52 subjects with Bell's palsy age ranged from 37.1 to 49.4 years	1. Stellate ganglion block (SGB) 2. LLLT 3. LLLT + SGB	Scale for assessment of facial palsy	>30 days	LLLT + SGB as effective as SGB or LLLT alone, LLLT alone shows however faster improvement
Yamada et al. [56]	Nonrandomized controlled trial	24 subjects with Hunt's syndrome II or Bell's palsy age ranged from 31.1 to 59.1	1. LLLT 2. LLLT + corticosteroids 3. Corticosteroids	Scale for assessment of facial palsy	5.3–8.9 weeks	LLLT as effective as corticosteroids, combination most effective

**Table 1.**  
*Characteristics of included studies*

Study	Random sequence generation (selection bias)	Allocation concealment (selection bias)	Blinding of participants (performance bias)	Blinding of outcome assessment (detection bias)	Incomplete outcome data (attrition bias)	Other sources of bias
Alayat et al. [52]	–	–	–	–	–	–
Kudoh et al. [53]	–	?	+	+	–	–
Ordahan et al. [54]	–	–	+	+	–	–
Murakami et al. [55]	+	+	+	+	–	–
Yamada et al. [56]	+	+	+	–	–	+

+, high risk of bias; –, low risk of bias;?, undetermined.

**Table 2.**  
*Risk of bias across the included studies*

at low risk, with one study however [53] having unclear concealment in allocation. Concerning the detection bias, only two studies had a defined strategy for blinding of outcome assessment [52, 56], and the other ones therefore appeared to be at high risk of bias [53–55]. Finally, all studies were found to be at low risk of attrition bias. No other sources of bias were found, except the low number of participants in one of the studies [56].

#### 4.2.4 LLLT effectiveness

Two studies [52, 54] showed that LLLT combined with facial exercise is more effective than facial exercise alone or in combination with a placebo laser. One study [53] found that LLLT combined with corticosteroids was more effective than corticosteroids alone, and another one [56] found that they are equally effective when prescribed separately but better when combined. Finally, the last study's [55] results support that LLLT is as effective as stellate ganglion block or the combination, but LLLT alone shows faster effects.

#### 4.2.5 Adverse events

Three of the included studies [53, 55, 56] specify that no side effects were noted following the LLLT.

#### 4.2.6 Overall strength of the evidence

The overall strength of the evidence was moderate. Most studies did not include patient blinding [53–56]. Moreover, three of the five studies [53–55] did not proceed to a blinding of outcome assessment which substantially increases the risk of bias. Overall, only one study [52] showed low risk of bias and high-quality evidence. In other words, further research is likely to have an important impact and may change our confidence in the estimate of effect of LLLT for the treatment of Bell's palsy.

### 4.3 Discussion

This literature review was conducted to investigate the effectiveness of LLLT for the treatment of Bell's palsy. In the included studies, usual treatments such as facial

exercise and corticosteroids were found to be less effective alone than when combined to LLLT [52–54, 56]. Moreover, isolated LLLT and corticosteroid treatments were compared and found to be equally effective [56]. This suggests that LLLT is a significant treatment modality for patients recovering from Bell's palsy. However, the lack of outcome assessment blinding [53–55] and patient blinding [53–56] in most studies meant that the risk of bias was relatively high and further research could change the estimate of effect of this treatment option. Only one study [52] showed low risk of bias and high-quality evidence (randomized double-blind placebo-controlled trial).

The understanding of the pathophysiology of Bell's palsy helps deduce the related hypothetical benefits of LLLT. The physiological changes related to this condition have been identified during a histopathological study of the facial nerve over the acute pathological phase and included infiltration of inflammatory cells, marked edema and myelin breakdown, as well as axonal changes [61].

The photochemical and physiological changes produced by LLLT when applied onto the involved site in patients affected by Bell's palsy include increase of cell propagation and migration, modulation in cytokines levels, inflammatory mediators and growth factors, and augmented tissue oxygenation [27]. They also include vasodilation related to photodissociation of nitric oxide (NO) [28], thus leading to further oxygenation of the targeted cells and allowing increased traffic of immune cells into tissues.

In line with these changes, we can assume that LLLT helps in controlling and reducing the inflammation, swelling, and edema causing compression of the facial nerve in its bony canal. It probably also helps improve the affected nerve's function. We can also hypothesize that the augmented influx of immune cells helps fight the potential causative infectious agent.

Several studies support each one of these theories individually. Whether in fighting infectious agents such as herpes simplex virus [62], reducing inflammatory infiltrate [63], reducing edema [64], or helping nerve function and recovery [65], LLLT has shown promising results.

Furthermore, with some studies showing that complete healing occurs in 70–85% of affected patients and the remaining 15–30% demonstrates incomplete recovery (weakness, hyperkinesia, and synkinetic contracture) [12–14], Bell's palsy becomes an often unpredictable pathology, and spontaneous recovery cannot be expected. Further literature refers to a 25% of affected people with incomplete recovery with traditional medicines and therapies and retaining remarkable sequel of the pathology that may have been avertible with complementary laser treatment within 15 days of diagnosis [66].

In conclusion, LLLT seems to be a good complementary medium reducing the possibility of side effects related to facial paralysis and allowing nerve recovery. In addition, it is painless, has no adverse effects, and is suitable for all type of patients, especially those who cannot use corticosteroids, such as diabetics and hypertensive patients [66].

## **5. Conclusion**

There is currently a moderate evidence to support the effectiveness of low-level laser therapy in the treatment of Bell's palsy. The results of the included studies suggest that LLLT may be a promising and safe treatment for this condition, but most of these studies were at substantial risk of bias. Further well-designed randomized double-blind placebo-controlled trials and high-quality studies are needed to determine with certainty the benefits of this treatment option for Bell's palsy.

## Conflict of interest

The authors declare that they have no conflict of interest.

## Abbreviation

LLLT	low-level laser therapy
ATP	adenosine triphosphate
ROS	reactive oxygen species
NO	nitric oxide
CN VII	facial nerve
HZV	herpes zoster virus
HSV-1	herpes simplex virus 1
SGB	stellate ganglion block

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## References

- [1] Cha CI, Hong CK, Park MS, Yeo SG. Comparison of facial nerve paralysis in adults and children. *Yonsei Medical Journal*. 2008;**49**(5):725-734
- [2] Facer GW. Facial nerve paralysis: Is it always Bell's palsy? *Postgraduate Medicine*. 1981;**69**:206-208, 211-213, 216
- [3] Musani MA, Farooqui AN, Usman A, et al. Association of herpes simplex virus infection and Bell's palsy. *JPMMA. Journal of the Pakistan Medical Association*. 2009;**59**(12):823-825
- [4] Danner CJ. Facial nerve paralysis. *Otolaryngologic Clinics of North America*. 2008;**41**:619-632
- [5] Tiemstra JD, Khatkhate N, Tiemstra JD, Khatkhate N. Bell's palsy: Diagnosis and management. *American Family Physician*. 2007;**76**(7):997-1002
- [6] Sajadi MM, Sajadi MR, Tabatabaie SM. The history of facial palsy and spasm: Hippocrates to Razi. *Neurology*. 2011;**77**:174-178
- [7] De Diego-Sastre JI, Prim-Espada MP, Fernández-García F. The epidemiology of Bell's palsy. *Revista de Neurologia*. 2005;**41**(5):287-290
- [8] Morris AM, Deeks SL, Hill MD, Midroni G, Goldstein WC, Mazzulli T, et al. Annualized incidence and spectrum of illness from an outbreak investigation of Bell's palsy. *Neuroepidemiology*. 2002;**21**(5):255-261
- [9] Tovi F, Hadar T, Sidi J, Sarov I, Sarov B. Epidemiological aspects of idiopathic peripheral facial palsy. *European Journal of Epidemiology*. 1986;**2**(3):228-232
- [10] Bradbury ET, Simons W, Sanders R. Psychological and social factors in reconstructive surgery for hemi-facial palsy. *Journal of Plastic, Reconstructive & Aesthetic Surgery*. 2006;**59**:272-278
- [11] Ho AL, Scott AM, Klassen AF, Cano SJ, Pusic AL, Van Laeken N. Measuring quality of life and patient satisfaction in facial paralysis patients: A systematic review of patient-reported outcome measures. *Plastic and Reconstructive Surgery*. 2012;**130**(1):91-99
- [12] Yanagihara N. Incidence of Bell's palsy. *Annals of Otology, Rhinology and Laryngology*. 1988;**97**(Suppl 137):3-4
- [13] Koike Y, Imamura H. Effects of early administration high-dose steroids on Bell's palsy. In: Castro D, editor. *The Facial Nerve*. Amstelveen: Kuger and Ghedini Publ; 1990. pp. 395-400
- [14] Peitersen E. Bell's palsy: The spontaneous course of 2,500 peripheral facial nerve palsies of different etiologies. *Acta Oto-Laryngologica. Supplementum*. 2002;**549**:4-30
- [15] Ilnczky S, Semmelweis E, Altalános Orvostudományi K, Neurológiai K. Clinical analysis of patients with peripheral facial palsy. *Ideggyógyászati Szemle*. 2006;**59**(11-12):400-405
- [16] Glass GE, Tzafetta K. Bell's palsy: A summary of current evidence and referral algorithm. *Family Practice*. 2014. pii: cmu058
- [17] Hohman MH, Hadlock TA. Etiology, diagnosis, and management of facial palsy: 2000 patients at a facial nerve center. *The Laryngoscope*. 2014;**124**(7):E283-E293. DOI: 10.1002/lary.24542
- [18] Devriese PP, Schumacher T, Scheide A, DeJongh RH, Houtkooper JM. Incidence, prognosis and recovery of Bell's palsy. A survey about 1000 patients (1974-1983). *Clinical Otolaryngology*. 1990;**15**:15-27
- [19] Sullivan FM, Swan IR, Donnan PT, Morrison JM, Smith BH, et al. Early treatment with prednisolone

or acyclovir in Bell's palsy. *The New England Journal of Medicine*. 2007;**357**(16):1598-1607

[20] Maiman TH. Stimulated optical radiation in ruby. *Nature*. 1960;**187**:493-494

[21] Mester E, Szende B, Tora JG. Effect of laser on hair growth of mice. *Kísérletes Orvostudomány*. 1967;**19**:628-631

[22] Hamblin MR. Mechanisms of low level light therapy. *Proceedings of SPIE*. 2009;**6140**:614001-614001

[23] Huang YY, Chen AC, Carroll JD, Hamblin MR. Biphasic dose response in low level light therapy. *Dose-Response*. 2009;**7**(4):358-383

[24] Greco M, Guida G, Perlino E, Marra E, Quagliariello E. Increase in RNA and protein synthesis by mitochondria irradiated with helium-neon laser. *Biochemical and Biophysical Research Communications*. 1989;**163**:1428-1434

[25] Karu TI. Primary and secondary mechanisms of action of visible to near-IR radiation on cells. *Journal of Photochemistry and Photobiology. B*. 1999;**49**:1-17

[26] Chen AC-H, Arany PR, Huang Y-Y, Tomkinson EM, Saleem T, Yull FE, et al. Low level laser therapy activates NF- $\kappa$ B via generation of reactive oxygen species in mouse embryonic fibroblasts. *Proceedings of SPIE*. 2009;**7165**:71650-71659

[27] Karu TI, Kolyakov SF. Exact action spectra for cellular responses relevant to phototherapy. *Photomedicine and Laser Surgery*. 2005;**23**:355-361

[28] Lohr NL, Keszler A, Pratt P, Bienengraber M, Warltier DC, Hogg N. Enhancement of nitric oxide release from nitrosyl hemoglobin and nitrosyl myoglobin by red/

near infrared radiation: Potential role in cardioprotection. *Journal of Molecular and Cellular Cardiology*. 2009;**47**:256-263

[29] Runge MS, Greganti MA. *Netter's Internal Medicine*. 2nd ed. Philadelphia (PA): Elsevier; 2009

[30] Jackson CG, von Doersten PG. The facial nerve. *Current trends in diagnosis, treatment, and rehabilitation. The Medical Clinics of North America*. 1999;**83**(1):179-195

[31] Liu J, Li Y, Yuan X, Lin Z. Bell's palsy may have relations to bacterial infection. *Medical Hypotheses*. 2009;**72**(2):169-170

[32] Aviel A, Ostfeld E, Burstein R, Marshak G, Bentwich Z. Peripheral blood T and B lymphocyte subpopulations in Bell's palsy. *The Annals of Otolaryngology, Rhinology, and Laryngology*. 1983;**92**(2 Pt 1):187-191

[33] Greco A, Gallo A, Fusconi M, Marinelli C, Macri GF, de Vincentiis M. Bell's palsy and autoimmunity. *Autoimmunity Reviews*. 2012;**12**(2):323-328

[34] Chaco J. Subclinical peripheral nerve involvement in unilateral Bell's palsy. *American Journal of Physical Medicine*. 1973;**52**(4):195-197

[35] Holland NJ, Weiner GM. Recent developments in Bell's palsy. *BMJ*. 2004;**329**(7465):553-557

[36] Schirm J, Mulkens PS. Bell's palsy and herpes simplex virus. *APMIS*. 1997;**105**(11):815-823

[37] Murakami S, Mizobuchi M, Nakashiro Y, Doi T, Hato N, Yanagihara N. Bell palsy and herpes simplex virus: Identification of viral DNA in endoneurial fluid and muscle. *Annals of Internal Medicine*. 1996;**124**(1 Pt 1):27-30

- [38] Baringer JR. Herpes simplex virus and Bell palsy. *Annals of Internal Medicine*. 1996;**124**(1 Pt 1):63-65
- [39] Mutsch M, Zhou W, Rhodes P, Bopp M, Chen RT, Linder T, et al. Use of the inactivated intranasal influenza vaccine and the risk of Bell's palsy in Switzerland. *The New England Journal of Medicine*. 2004;**350**(9):896-903
- [40] Couch RB. Nasal vaccination, escherichia coli enterotoxin, and Bell's palsy. *The New England Journal of Medicine*. 2004;**350**(9):860-861
- [41] Morgan M, Nathwani D. Facial palsy and infection: The unfolding story. *Clinical Infectious Diseases*. 1992;**14**(1):263-271
- [42] Bitsori M, Galanakis E, Papadakis CE, Sbyrakis S. Facial nerve palsy associated with *Rickettsia conorii* infection. *Archives of Disease in Childhood*. 2001;**85**(1):54-55
- [43] Wolfson AB. *Narwood-Nuss' Clinical Practice of Emergency Medicine*. 5th ed. Philadelphia (PA): Lippincott Williams & Williams; 2009
- [44] Goroll AH, Mulley AG. *Primary Care Medicine: Office Evaluation and Management of the Adult Patient*. 6th ed. Lippincott Williams & Williams: Philadelphia (PA); 2009
- [45] Merwarth HR. The occurrence of peripheral facial paralysis in hypertension vascular disease. *Annals of Internal Medicine*. 1942;**17**:298-230
- [46] Raff MC, Asbury AK. Ischemic mononeuropathy and mononeuropathy multiplex in diabetes mellitus. *The New England Journal of Medicine*. 1968;**279**(1):17-21
- [47] Schaitkin BM, May M, Podvinec M, et al. Idiopathic (Bell's) palsy, herpes zoster cephalicus, and other facial nerve disorders of viral origin. In: May M, Schaitkin BM, editors. *The Facial Nerve: May's*. 2nd ed. New York: Thieme Medical; 2000. pp. 319-338
- [48] He L, Li M, Long XH, Li XP, Peng Y. A case of Hashimoto's encephalopathy misdiagnosed as viral encephalitis. *American Journal of Case Reports*. 2013;**14**:366-369
- [49] JPT H, Green S. *Cochrane Handbook for Systematic Reviews of Interventions*. Chichester, England: John Wiley & Sons Ltd; 2011. (Version 5.1.0): Chapter 8
- [50] Cochrane Effective Practice and Organisation of Care. EPOC-specific resources for review authors. 2016. Available at: <http://epoc.cochrane.org/resources/epoc-resources-review-authors>. [Accessed: June 10, 2016]
- [51] Andrews JC, Schünemann HJ, Oxman AD, et al. GRADE guidelines: 15. Going from evidence to recommendation—determinants of a recommendation's direction and strength. *Journal of Clinical Epidemiology*. 2013;**66**(7):726-735
- [52] Mohamed A, Ahmed ES, Amir E-F. Efficacy of high and low level laser therapy in the treatment of Bell's palsy: A randomized double blind placebo-controlled trial. *Lasers in Medical Science*. 2014;**29**(1):335-342. DOI: 10.1007/ s10103-013-1352- z
- [53] Kudoh A, Yodono M, Ishihara H, Matsuki A. Linear polarized light therapy improves Bell's palsy. *Laser Therapy*. 1998;**10**(2):65-69. Released July 05, 2011, Online ISSN 1884-7269, Print ISSN 0898-5901
- [54] Banu O, Ali K. Role of low level laser therapy added to facial expression exercises in patients with idiopathic facial (Bell's) palsy. *Lasers in Medical Science*. 2017;**32**(4):931-936. DOI: 10.1007/ s10103-017-2195-9

- [55] Murakami F, Kemmotsu O, Kawano Y, Matsumura C, Kaseno S, Imai M. Diode low reactive level laser therapy and stellate ganglion block compared In the treatment of facial palsy. *Laser Therapy*. 1993;5(3):131-135. Released April 18, 2012, Online ISSN 1884-7269, Print ISSN 0898-5901
- [56] Yamada H, Yamanaka Y, Orihara H, Ogawa H. A preliminary clinical study comparing the effect of low level laser therapy (Lllt) and corticosteroid therapy In the treatment of facial palsy. *Laser Therapy*. 1995;7(4):157-162. Released January 11, 2012, Online ISSN 1884-7269, Print ISSN 0898-5901
- [57] Ng SY, Chu MHE. Treatment of Bell's palsy using monochromatic infrared energy: A report of 2 cases. *Journal of Chiropractic Medicine*. 2014;13(2):96-103. DOI: 10.1016/j.jcm.2014.06.010
- [58] Okuni I, Harada T, Ushigome N, Ohshiro T, Musya Y, Maruyama Y, et al. Low level laser therapy (LLLT) for facial palsy patients. *Laser Therapy*. 2008;17:135-139. DOI: 10.5978/islsm.17.135
- [59] Rubis LM. Chiropractic management of Bell palsy with low level laser and manipulation: A case report. *Journal of Chiropractic Medicine*. 2013;12(4):288-291. DOI: 10.1016/j.jcm.2013.10.001
- [60] Yoshida K. Lllt for facial palsy. *Laser Therapy*. 2010;19:167-169. DOI: 10.5978/islsm.19.167
- [61] Linder T, Bossart W, Bodmer D. Bell's palsy and herpes simplex virus: Fact or mystery. *Otology & Neurotology*. 2005;26:109
- [62] Schindl A, Neumann R. Low-intensity laser therapy is an effective treatment for recurrent herpes simplex infection. Results from a randomized double-blind placebo-controlled study. *The Journal of Investigative Dermatology*. 1999;113(2):221-223
- [63] Paiva-Oliveira EL, Lima NC, Silva PH, et al. Low-level laser therapy (LLLT) reduces inflammatory infiltrate and enhances skeletal muscle repair: Histomorphometric parameters. *Laser Physics*. 2012;22:1425
- [64] Stergioulas A. Low-level laser treatment can reduce edema in second degree ankle sprains. *Journal of Clinical Laser Medicine & Surgery*. 2004;22(2):125-128
- [65] Rochkind S, Drory V, Alon M, Nissan M, Ouaknine GE. Laser phototherapy (780 nm), a new modality in treatment of long-term incomplete peripheral nerve injury: A randomized double-blind placebo-controlled study. *Photomedicine and Laser Surgery*. 2007;25:436-442. DOI: 10.1089/pho.2007.2093
- [66] Bernal G. Helium neon and diode laser therapy is an effective adjunctive therapy for facial paralysis. *Laser Therapy*. 1993;5:79-87