

Facial Rehabilitation

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ABSTRACT

Facial nerve palsy (FNP) changes facial expression and leads to functional problems in facial movement and negative psychological effect on patients. Fortunately, some of FNP problems recover completely, but some others remain with some sequelae like asymmetry, muscle contracture, synkinesis, and hyperkinesias that need rehabilitation. This article aimed to investigate physiotherapy modalities on these sequelae. Generally, exercise therapy in the form of neuromuscular reeducation was effective when the sequelae of FNP are analyzed. Then, we could select the type of exercise therapy according to that signs and sequelae (symptom). No acceptable researches about physiotherapy modalities like electrical nerve stimulation have been reported. Therefore, using electrical stimulation is not advised. Biofeedback therapy has been approved to be suitable.

Introduction

Unlike skeletal muscles, facial muscles attach to bone and soft tissues. On the other hand, these muscles are small with minimal contraction. These muscles not only contribute in eating, drinking, and speaking, but also create expressional signs reflecting psychosocial expressions [1-3]. Even, changes in facial expressions can be recorded in electromyography (EMG) [4]. The patient with FNP or weakness may have no significant problem in eating, drinking, or speaking but it has negative effect on facial expressions. Patients with FNP hide their sudden laugh for fear of facial deviation. This causes social problem and loss of quality of life [5,6].

Facial nerve is the most common cranial nerve that is usually injured unilaterally. Half of all peripheral FNP cases are idiopathic (Bell's palsy) and the remainders are due to tumor, trauma, injury during surgery, and herpes zoster oticus (Ramsay Hunt syndrome) [6-8]. The severity of FNP depends on the type and location of facial nerve injury (9). The incidence of Bell's palsy is 23 - 35 cases in 100,000 [10-12]. Complete spontaneous recovery

in Bell's palsy was seen in 70% of cases. This recovery takes some weeks or some months [11]. Thirty percent with incomplete recovery suffer from facial muscles weakness, contracture, hyperkinesis, hyperlacrimation, asymmetry, atrophy, and synkinesis [13-16]. Among these sequelae, asymmetry and synkinesis, related to patients' expression are the most important sequelae. Synkinesis is an abnormal involuntary facial movement that occurs simultaneous with voluntary movement of a different facial muscle group [14,17]. Synkinesis begins 3 to 4 months after regeneration of FNP and continues up to 2 years. The most common types of synkinesis are oral-ocular and ocular-oral [18].

Ocular synkinesis is involuntary oral movements during voluntary ocular movement and oral synkinesis is involuntary ocular movements during voluntary oral movements (14). Cause of synkinesis is not entirely known [10,14,17]. Malregeneration in facial nerve fiber can be the cause of synkinesis [19, 20]. However, prevention and correction of these sequelae are more important and are considered as physiotherapist's responsibility (21). This article is the outcome of gathering 328 clinical trials and review articles extracted from Else-

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vier, Ovid Medline, Informa, PubMed, Springer, Google Scholar, EBSCO in English language between 1958 to 2014. The aim of this article was to introduce rehabilitation treatment and present the best treatment protocol for complete recovery of FNP.

Diagnosis and Severity of Facial Nerve Injury

Clinical and paraclinical evaluations for diagnosis of severity of injury and forecast the sequels of FNP [19, 22] are the first step in scheduling rehabilitation [23, 24]. There are several ways for evaluation of facial injuries; the most common are House Brakeman [25, 26] (Table 1) and facial grading system, which the latter is more suitable because of its indicating of gradual changes in static and dynamic expression [26] (Table 2). Another suitable evaluation method that we used in our research is Photoshop method. In this method, the photos captured in resting and four dynamic basic expression (wrinkle, snarl, smile, lip pucker) and the changes of both sides of face calculated with quantity unit [27, 28]. The other method is Facial Disability Index, which measures the disability of patient in 2 groups of functional and psychological questions [29]. Suitable paraclinical methods are maximum irritability, electroneuronography (ENOGNoG), and electromyography (EMG). Maximum irritability and electroneuronography are valuable if done between the 7th and 10th days of injury [24], whereas EMG is valuable between the 14th and 21st days of injury [34, 35]. The patients with FNP, which have denervation signs need long duration of rehabilitation and those with neuroapraxia (because of spontaneous recovery) and neurothemsis (need for surgery) do not need physical therapy.

Management

Medication, surgery, rehabilitation and lately botulinum toxin type A (BTX-A) for treatment of FNP have been recommended. But all of them are controversial [10, 36-38]. Although in acute phase of FNP, especially Bell's palsy Acyclovir or steroid has been prescribed, unfortunately no single randomized control trial has achieved an unquestionable benefit using oral steroid therapy [10]. When conservative treatments do not have positive effects, surgery, including neurolysis, facial nerve graft, cut of tendon, or muscle graft to face is the treatment choice. In some cases for removing synkinesis, surgery is recommended. Selective neurolysis may relieve synkinesis temporarily; however, synkinesis frequently recurs, sometimes more severe compared to status before the intervention. Selective myectomy, on the other hand, has a low recurrence rate, but postopera-

tive complications such as swelling, hematoma, lymphoedema, and ecchymosis may occur [39,40]. The effect of BTX-A for synkinesis was studied since two decades ago (41,42). BTX-A injection may achieve significant relief of synkinesis by blocking the presynaptic release of acetylcholine and causes functional denervation in motor end plate (43,44). According to available articles, synkinetic movements are disappeared a few days after injection and remains until 3-7 months [44]. Because of the temporary effect of BTX-A, further injection may be necessary [14, 43]. The injection of BTX-A is limited to one or some points in face and needs exercise therapy for removing contracture, tension, and asymmetry. On the other hand, BTX-A injection in cases with hyperactive muscles reduce the activity of their activity, whereas it's injection in semi-paralyzed muscle, which may increase asymmetry. Also with high dose, side effects such as ptosis, eye dryness, and chewing problems resulting from muscle weakness may occur [43]. Anyway, several studies on BTX-A for reducing synkinesis have been done. In some studies, repeated injection of BTX without bio-feedback [42] is recommended, while in some others using high or low dose of BTX-A with [40] or without bio-feedback was recommended [16]. All mentioned studies reported reduction in synkinesis.

Physical Therapy Modalities

Jebejian investigated the anti-inflammatory effect of ultrasound and demonstrated that it prevents inflammation and denervation [45]. This study was done without a control group with limited sample size and no similar study investigated the effect of ultrasound. Using electrical stimulation (faradic and pulse galvanic) in peripheral facial nerve injuries reported antithesis [46]. Some researchers used electrical stimulation for sophisticated contraction and even in some studies, Transcutaneous Electrical Nerve Stimulation TENS was recommended [47]. Anyway, clinical trial study in this context is limited and related to four decades ago. It is reported beneficial in some studies [48, 49], whereas in some other studies, electrical stimulation is reported to be harmful [50]. In fact, physiologically, electrical stimulation creates contraction in nerve, or muscle(s).

Thus, short duration stimulation (Faradic or FES) could not induce contraction in denervated or injured fibers and if any contraction observed, it is related to innervated and sound muscle fibers [51]. Therefore, long duration stimulation (pulse galvanic) should be used [52]. First of all, long duration stimulation is annoying for patients; second, these stimulations could neither prevent atrophy nor regenerate the nerve [51, 52]. Third, they could cre-

Table 1. House-Brackmann grading system for facial palsy

Grade 1	Normal function
Grade 2	Mild dysfunction
Grade 3	Reduced forehead movement, noticeable synkinesis and contracture
Grade 4	No forehead movement, incomplete eye closure, asymmetric mouth, disfigure in asymmetry
Grade 5	Minimal movement
Grade 6	No movement

PHYSICAL TREATMENTS

ate mass movement and increase synkinesis [53]. Previous research about physiotherapy modalities is very old and not very documented to be referenced. It seems that the base of using physiotherapy modalities is according to function and nature of it. Review article of Quinn in 2003 about physiotherapy modalities believed that none of them has priority and we could not recommend a special modality [54]. Review article and selective clinical trial studies of Teixeira in 2008, compared electrical stimulation, exercise therapy, and control group. They reported that exercise therapy group had better results and it reduced improvement duration [55]. However, previous research showed physiotherapy modalities is necessary for reeducation [6, 7, 43, 56]. Hence, this article aimed to describe this type of exercise therapy.

Exercise Therapy

According to above notes, researchers paid significant attention to exercise therapy as neuromuscular reeducation in different ways and emphasized on its effect [6, 7, 13, 24, 34, 35, 39, 57, 59-63], but the used methods and instruments are different [23, 63]. These methods comprised EMG biofeedback, mirror biofeedback, mime therapy (combination of thermotherapy, massage, and neuromuscular reeducation) [61], active, active-assistive, and resistive exercise [63].

For example, Toffalo et al. (2005) investigated the effect of manual exercise (active-assistive) and EMG biofeedback and reported the more effectiveness of the second method [64]. Toffalo in another study (2012) compared EMG biofeedback and mirror biofeedback, and the results showed that both of them were effective but no significant differences were observed between two groups [65]. Pourmomeny et al. (2013) compared EMG biofeedback and common physiotherapy management for prevention and reducing synkinesis, and finally EMG biofeedback was reported as a more effective method [23]. Cardoso in a review article (2008) about exercise therapy could not do meta-analyses due to the lack of clinical studies [56]. However in previous stud-

ies, neuromuscular reeducation was reported as the most effective treatment protocol [26, 56]. Supporting this technique comes from the fact that the facial muscles do not have internal sensory receptors producing proprioception [39, 40, 57] and unlike skeletal muscles, facial muscles do not closure with facial shields [67, 68]. Accordingly, they are very small and dirigible with minimal contractions with high risk for contracture and change in movement pattern, so the exercise therapy should be done delicately through neuroplasticity. Hence, visual and auditory biofeedback are suitable for neuromuscular reeducation [69, 70] and can facilitate the movement. For this reason, biofeedback instruments, especially EMG are suitable. Theoretically, biofeedback is the presentation of special, exact, correct and wrong movement during expression or facial muscle activity [70]. Usually movements of facial muscles in FNP are limited in these two ways:

- 1-A muscle should move but it cannot because of several reasons.
- 2-A muscle should not move but it moves involuntarily (synkinesis).

Biofeedback informs the patient about the quality of movement by correcting movement pattern. In fact, it is an instrument for neuromuscular reeducation. The patients hear or see muscle activity pattern and decide to change or strengthen it. The sensitivity of EMG biofeedback instrument, is set according to power of facial muscle in order to strengthen or eradicate muscle activity and in cases that the aim of treatment is to produce symmetry of both sides of face (for reducing and prevention of synkinesis), several canals of EMG biofeedback are used simultaneously. In fact, biofeedback therapy for facial nerve injuries is a neuroplasticity way for patients with facial nerve palsy or patients that cannot coordinate sound and injured side [13]. The function of mirror biofeedback is like EMG biofeedback, it does not need instrument but it has low delicacy.

Table 2. Facial grading system.

Patients' name		Date:					DX:				
Resting symmetry		Dynamic (Symmetry of voluntary movement)					Synkinesis				
Compared to normal side		Degree of muscle movement (Compared to normal side)									
Eye	(choose one option):	Standard expressions	Unable initiate movement	Initiate slight movement	Initiate movement with mild excursion	Movement almost complete	Movement complete	None	Mild	Moderate	Severe
	Normal 0 Narrow 1 Wide 1 Eyelid surgery 1										
Cheek (nasolabial fold):	Fore-head wrinkle	1	2	3	4	5	0	1	2	3	
	Normal 0 Absent 2 Less pronounced 1 More pronounced 1 eye Close	1	2	3v	4	5	0	1	2	3	
Mouth:	Smile	1	2	3	4	5	0	1	2	3	
	Normal 0 Corner drooped 1 Corner pulled 1	1	2	3	4	5	0	1	2	3	
	snarl Lip pucker	1	2	3	4	5	0	1	2	3	
Sum <input type="checkbox"/>		Sum <input type="checkbox"/>									
Score total x5 <input type="checkbox"/>		Score total x 4 <input type="checkbox"/>						Synkinesis score <input type="checkbox"/>			
Voluntary movement score <input type="checkbox"/> - (Resting symmetry score <input type="checkbox"/> + synkinesis score <input type="checkbox"/>) = complete score <input type="checkbox"/>											

PHYSICAL TREATMENTS

Van Swearingen classified management of FNP according to the sign and symptoms and suggested exercise therapy based on the symptoms (muscle weakness, asymmetry, contracture, and synkinesis), regardless of its etiology [68]. We followed the same procedure. Our treatment was based on education and using feedbacks for reeducation. The patient should be completely aware of his movement disability, so the emphasis was on education. Then, reeducation and movement skill and finally, strengthening the movement were emphasized. The best instrument for this process is EMG or mirror biofeedback. The patients were divided into 4 groups according to the signs and symptoms.

People in the first group, (in resting position) have deformity, asymmetry, dropping corner of lip, dropping inferior palpebral, minimal or no contraction in injured side, problem in closing eye, drinking and chewing. This group has two subgroups:

A: Patients diagnosed with neurothemesis in electrodiagnosis with passing a very long time out of their injuries. Physiotherapy was not effective in these patients before repairing or correcting surgery (neurolysis, nerve graft, tendon, or muscle transfer). After surgery, depending on the type of surgery, the patients were put into one of these four groups.

B: Patients with acute facial nerve palsy. Spontaneous recovery is probable, but it is not common to leave patients to spontaneous recovery. Thus, the rehabilitation is the same as other damages in this group and need physiotherapy.

Suitable management for these patients was informing of their disability through mirror. Active-assistive exercise is the best choice for exercise therapy. Exercise therapy and reeducation in type of active-assistive exercise were educated. Massage and light stretch with the aim of improving blood flow of soft tissue and damaged

muscles was done. Then, the patients were asked to help move the paralyzed muscle through their hand (for example, if the aim of the movement is smiling, the patient put his hand over the orbicularis muscle and helps the muscle to move through active movement or if the aim of movement is to wrinkle, the patient helps the frontalis muscle through finger to move it actively).

In these patients, if there is some minimal contraction in damaged muscles, the patients were asked to induce the injured side to move by little movement of the sound side (this action would be done properly in front of the mirror with point placing in the injured side). In short, the start of movement of the paralyzed muscle should be facilitated. When the muscle fibers of injured sides are in the proper length and tension, the movement will be facilitated. For this reason, the movement of the sound side should not cause stretch in the injured side. Finally, followed by the improvement of muscle contraction, active-assistive movements transform to strengthening and active educational movements.

In the second group, duration of facial palsy has past at least 6 months and they had somehow voluntary contraction, minimal asymmetry in resting position, and no or minimal synkinesis. Asymmetry was less than that of the first group. The patients could start the movement but they could not control injured muscles, so the asymmetry increased by movements. The best treatment protocol in this group is facilitation of movements, neuromuscular reeducation, active, and active-assistive exercise. Therefore, the movements in the injured side should be facilitated.

We educated the patients to start the movement slowly and control the beginning of movements. For example, to smile, the patients should start the movement slowly with the control over the injured side without movement of corner of lip on the sound side. The exercises should be done in front of the mirror or EMG biofeedback due to the lack of proprioception and muscle spindle in face. The patients should notice involuntary movements (synkinesis). We could also use biofeedback therapy on the muscles of sound side or synkinetic muscles to control synkinesis during voluntary movements.

In the third group, the patients had asymmetry and synkinesis in face, the eye was smaller, the fulcrum of upper lip tilted in sound side, the corner of lip was drooping, voluntary movements were not complete. The asymmetry was due to contracture in soft tissue rather than muscle weakness. The patient may have hyperlacrimation and during eating, drinking, and yawing, the eye be-

comes smaller. The best treatment protocol for these patients was the rmotherapy (light heat for some minutes), massage, stretching, and neuromuscular reeducation by mirror or EMG biofeedback. The aim of neuromuscular reeducation in this group was prevention and controlling synkinesis. In fact, we asked the patients to move the muscles one by one. For this reason, using EMG biofeedback by 2 or 3 canals synchronously was the best treatment protocol.

In the last group, the patients had tension or spasm in the injured side in resting position. Synkinesis may be seen in resting position in one or more regions of the face in the form of tic. The voluntary movements were more than 50% of the sound side. However, it affects contracture and tension of the soft tissue. For this reason like previous groups, they had asymmetry during voluntary movements but the severity of synkinesis was more than other groups. The best treatment protocol was surface heat, stretch, rhythmic motion, relaxation, neuromuscular reeducation, and correct pattern of movement. We can use for relaxation and education of the correct pattern of movements and reducing synkinesis, we can use biofeedback. Also, in cases with complete facial nerve palsy in which the patient needs one of repairing surgeries, according to the type of surgery, physiotherapy is recommended as mentioned before.

The use of BTX-A for the management of synkinesis had been studied for two decades [41, 42]. Significant relief of synkinesis may be achieved by injecting BTX-A to block the presynaptic release of acetylcholine, causing partial functional paralysis in motor end plate [43, 44]. Synkinetic movements will be disappeared a few days after injection and remained until 3-7 months [44]. However, using high doses of BTX-A may lead to side effects such as ptosis, eye dryness and chewing problems resulting from muscle weakness [43]. Also, because the effect of BTX-A is temporary, repeated injections may be required [14, 43]. Repeated injection of BTX-A without biofeedback [42] and low or high dose of BTX-A with [40] or without biofeedback [16] have been recommended.

Usually the sequelae of facial nerve palsy are not limited to synkinesis, but asymmetry, tension, and contracture are included too. In addition, the effect of BTX is temporary and increases the severity of paralysis and the effect of BTX is limited to one point and asymmetry between the sound and injured side, contracture, and tension remains. Another study investigated and compared the combination of BTX and biofeedback with biofeedback alone. The first result showed improvement

in symmetry and reducing synkinesis in both groups but no significant difference between two groups were observed after 4 months of treatment. In fact, biofeedback is alone enough for improvement of symmetry without BTX injection.

Results

Over half of the patients with FNP need physical therapy. Some studies suggest electrical stimulation, but no acceptable scientific research has been done for electrical stimulation apart from some other physical therapy modalities (ultrasound, diathermy, and laser). However, they seem to have side effects. Among these studies, exercise therapy in type of neuromuscular reeducation is the best treatment protocol if the base of treatment is the analysis of the signs and symptoms. Considering delicacy and low ROM of facial muscles, the base of the facilitation of movement, controlling it, and reducing synkinesis should be provided. In cases with contracture and muscle stiffness, exercise therapy like relaxation should be done along with biofeedback (EMG and mirror) that is effective.

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