# Efficacy of Tape Feedback Therapy on Synkinesis Following Severe Peripheral Facial Nerve Palsy

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**Background: Mirror feedback rehabilitation is effective in preventing the development of oro-ocular synkinesis following severe facial palsy. However, we do not have effective maneuvers to prevent the deterioration of oculo-oral synkinesis. We developed a new method of biofeedback rehabilitation using tape for the prevention of oculo-oral synkinesis.**
**Objective: The aim of the present study was to investigate the efficacy of taping feedback rehabilitation.**
**Methods: Twelve consecutive patients with peripheral facial nerve palsy who developed synkinesis were divided into 2 groups. Six patients were treated with the new training method, and the remaining 6 patients were treated with conventional therapy as controls. In the experiment group, tape was placed around the mouth, and the patient was instructed to close the eyes so that no movements of the mouth would be perceived from sensations of the taped skin. After 4 weeks of training, facial movements were recorded and movie images were graded for mouth synkinesis using the revised Sunnybrook facial grading system by examiners blinded to patient grouping.**
**Results: Mouth corner contraction during eye closure was significantly weaker in the experimental group than in the control group.**
**Conclusions: Our new feedback method could help prevent the deterioration of oculo-oral synkinesis.**

**Key words: facial nerve palsy, synkinesis, rehabilitation, biofeedback**

## INTRODUCTION

Peripheral facial nerve palsy (FNP) is sometimes encountered in rehabilitation medicine. Bell's palsy and Ramsay Hunt syndrome are common causes of FNP. Approximately 30 % of patients with Bell's palsy who do not receive appropriate treatment may suffer from incomplete recovery [1]. Synkinesis is the most unpleasant sequela of peripheral facial palsy, representing an abnormal involuntary associated facial movement, such as eye closure during smiling (oro-ocular synkinesis) or mouth movement during blinking (oculo-oral synkinesis). In severe cases, the facial muscles shorten due to frequent co-contraction with the synkinesis in the chronic phase and bring about a sustained and unpleasant sensation of stiffness and discomfort in their affected cheek, which has a significant impact on their quality of life (QOL). The mechanism underlying synkinesis is mis-innervation that develops during the process of facial muscle re-innervation. As established synkinesis appears difficult to deal with, prevention of synkinesis is considered important [2].

Mirror feedback rehabilitation is effective in preventing the development of oro-ocular synkinesis, which involves involuntary eye closure during smiling, eating and other mouth movements. Patients are instructed to try keep the eyes open symmetrically during voluntary mouth movements (lip pursing, teeth baring, cheek puffing). This feedback should be initiated at the first sign of facial motor recovery [3].

On the other hand, finger sensory feedback rehabilitation has been generally prescribed to prevent oculo-oral synkinesis. This synkinesis involves involuntary movement of the mouth corner while closing the eyes [4]. The patient is asked to lightly touch with their fingers to their cheeks in order to perceive any unwanted mouth contractions during eye closure (Fig. 1). In other words, they have to close the eyes as gently as possible so as to avoid creating movements of the mouth that will be perceived by the fingers. The aim of this therapy is to avoid mass contraction of facial muscles and to progress the cortical reorganization for the movements of facial muscles separately. However, we encountered some cases in which involuntary mouth contractions continued even after performing this conventional sensory feedback from the acute phase. Although biofeedback therapy is effective when initiated as the symptoms of synkinesis appear, finger sense is not sensitive enough to perceive subtle involuntary movements of the mouth in the acute phase, especially among older patients.

The purpose of this study was to investigate the efficacy of taping feedback rehabilitation in preventing

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**Fig. 1** Illustration of finger sensory feedback therapy. Patients are asked to place their fingers on their cheeks as a light touch in order to perceive any unwanted contractions at the nasolabial level during eye closure.

**Fig. 2** Illustration of taping feedback therapy. Patients are taped around the mouth to fix the mouth corner lightly with medical tape. Patients have to close the eyes as gently as possible so as to avoid movements of the mouth that will be perceived by the skin around the mouth.

the deterioration of oculo-oral type synkinesis.

## MATERIALS AND METHODS

### Subjects

Outpatients with FNP who were referred to our rehabilitation center by an otolaryngologist for rehabilitative intervention were recruited. All subjects met the following inclusion criteria: a) peripheral FNP for the first time (Bell's palsy or Hunt's syndrome); b) Electroneurography (ENoG) less than or equal to 30 % (the amplitude of affected side facial muscles was reduced greater than or equal to 70 % compared to non-affected side) within 2 weeks after onset; and c) sufficient cognitive ability to follow instructions. Patients were excluded if they had other causes of FNP, such as tumor or trauma. All patients understood the aim and necessity of the training and provided informed consent prior to enrolment. This research was approved by our institutional review board (16R-168). The investigation conforms with the principles outlined in the Declaration of Helsinki.

### Tape feedback therapy

We therefore tried placing tape around the lips to identify weak contractions, not by the sense of touch with the fingers, but by the superficial sense of the skin around the mouth (Fig. 2). Patients were instructed to try avoid movement of the corner of the mouth on the affected side in a symmetrical manner to the unaffected side during eye closure. In other words, the eyes had to be closed as gentle as possible to avoid mouth movements on the affected side that would be perceived.

### Training method

The aim of this new training method was focused on preventing contraction of the corner of the mouth during mild eye closure. Training was initiated when the symptom of muscle contraction was observed on the affected side. Patients were prescribed 20 slow closures of the eyes per session, performing 3 sessions per day for 4 weeks.

### Evaluation

The degree of feeling sensitivity for contraction of the mouth corner during eye closure is graded on a three-point scale from 1 (no feeling) to 3 (feel strongly). We asked all subjects in the experimental group to grade this feeling under both taping sensory feedback and conventional finger sensory feedback when the symptoms of oculo-oral type synkinesis appeared.

All patients were treated with our training method of taping feedback rehabilitation (experimental group) and facial movements (resting state and mild eye closure) were digitally recorded after 4 weeks of training and compared to the movements on pre-recorded movies of other subjects trained using conventional finger sensory feedback therapy (control group). Facial movements were recorded and stored on the hard disk drive of a personal computer (Life Book SH75/W; Fujitsu, Tokyo, Japan). Movie images of the two groups were randomly arranged and graded for mouth corner synkinesis and resting symmetry using the revised Sunnybrook facial grading system by doctors and speech therapists who were blinded to patient groupings. The degree of synkinesis (mouth corner contraction during eye closure) was graded on a 4-point scale from 1 (no synkinesis) to 4 (severe synkinesis). Resting

**Table 1** The demographic data of experimental and control groups.

| characteristics | Experimental group | Control group | p |
|---|---|---|---|
| Age (y) | 47.3(16.5) | 55(18.4) | .47 |
| sex | | | .57 |
| Male | 2 (33.3) | 4 (66.6) | |
| Female | 4 (66.6) | 2 (33.3) | |
| diagnosis | | | 1 |
| Bell | 3 (50) | 4 (66.6) | |
| Hunt | 3 (50) | 2 (33.3) | |
| Duration from the onset (d) | 274(192.7) | 405(262.3) | 1.15 |
| ENoG (%) | 8.3(9.9) | 4.8(7.7) | .68 |

Differences between the 2 groups were not significant in any of the parameters (age, sex, diagnosis, duration from the onset and ENoG).

**Table 2** The grade of sensitivity with oculo-oral type synkinesis.

| | Taping feedback | Finger sensory feedback | p |
|---|---|---|---|
| Sensitivity with synkinesis (mouth corner contraction) | 2.83(0.41) | 1.17(0.41) | .003* |

All subjects recognized the high feeling sensitivity with mouth corner movement with taping feedback therapy compared to the conventional finger sensory feedback therapy.

**Table 3** The degree of synkinesis and resting symmetry.

| | Experimental group | Control group | p |
|---|---|---|---|
| synkinesis | 1.81(0.36) | 2.68(0.69) | .01* |
| eye | 1.68(0.57) | 1.61(0.74) | .68 |
| naso-labial fold | 2.18(0.47) | 2.60(0.47) | .03* |
| mouth | 1.88(0.74) | 2.10(0.38) | .82 |

In the experimental group, mouth corner contraction during eye closure was significantly weaker, and the naso-labial fold was significantly shallow compared to the control group.

symmetry was assessed by comparing the affected side with the unaffected side, with grading the following on a scale of 1 to 3: the palpebral fissure (1 = narrow, 2 = normal, 3 = wide), naso-labial fold (1 = shallow, 2 = normal, 3 = deeper), and corner of the mouth (1 = dropped, 2 = normal, 3 = pulled up).

### Statistical analysis

Comparisons between groups and treatments were performed using Fisher's test following the chi-square test when the variable was measured on a nominal scale, and using the Mann-Whitney test when the variable was measured on an ordinal scale. The significance level was set at .05, and 2-tailed tests were performed. Statistical calculations were performed using SPSS 13.0 for Windows (MapInfo Corporation, Troy, NY).

## RESULTS

Table 1 presents the demographic data of the experimental and control groups (n = 6 each). No significant differences between groups were seen in any parameters (age, sex, diagnosis, duration from the onset, and ENoG).

Table 2 presents the sensitivity with oculo-oral synkinesis. All subjects achieved more sensitive recognition of mouth corner movement with taping feedback therapy than with conventional finger sensory feedback therapy.

Table 3 shows the degree of synkinesis and resting symmetry. Mouth corner contraction during eye closure in the experimental group was significantly weaker, and the naso-labial fold was significantly shallower in the experimental group than in the control group. However, the degrees of palpebral fissure and the position of corner of the mouth were not significantly different.

## DISCUSSION

In our study, all subjects more easily identified oral synkinesis with taping feedback than with finger sensory feedback. After 4 weeks of exercise, involuntary mouth movement during eye closure was significantly weaker, and the naso-labial fold was significantly shallower in the experimental group compared to the control group. In other words, taping feedback could help prevent the deterioration of oral synkinesis.

Biofeedback therapies allow patients to more precisely perceive muscle contractions and relaxations, and to perform gradual, slow, controlled movements that can limit the development of synkinesis [4]. As mentioned above, initiating biofeedback therapy before the deterioration of synkinesis is important. Precise clinical assessment is therefore indispensable to avoid overlooking symptoms of synkinesis. Selecting a manner of sensory input that the patient is sensitive to and a manner of training that the patient can easily perform in daily life is also crucial. All patients experienced difficulty identifying mouth contractions through finger sensation alone at the beginning of oral synkinesis. Conversely, they recognized mouth corner movement using taped lips with high sensitivity. We presumed that finger sensation was not sensitive enough for perceiving subtle involuntary movements of the mouth. One reason might be that finger sense depends on the palp, a small area of the fingertip, while a broader area of taped skin allowed the perception of mouth synkinesis. Fixation of the mouth with taping could allow greater sensitivity to the movement of the lips. Another contributor is that some elderly subjects could not distinguish between subtle movements of the fingertip and mouth, confusing the sensations from the ventral side of the second finger (median sensory nerve) and the upper lips (second branch of the trigeminal nerve).

Pourmomeny reported that biofeedback electromyography (EMG) as the proper conservative therapy for FNP [2]. However, continuing such training as a home exercise is difficult, as an EMG device is needed. Our new training method needs only a few pieces of tape of the appropriate length to fix the lip. Tape is inexpensive and portable and provide the patient with immediate feedback regarding performance. In addition, after several uses of taping feedback treatment, subjects begin to easily identify oral synkinesis without taping. We assumed the reason that superficial sense with taped skin could reinforce the proprioceptive sense of the mouth. Taping feedback might thus be more suitable for home exercises than EMG feedback.

FNP is a disease of pure sensory-motor mismatch. In the acute phase of FNP, Klingner reported that the motor system did not make a major attempt to solve sensorimotor discrepancies by modulating the motor program in a study using functional MRI [5]. Instead, altered functional connectivity to the secondary somatosensory cortex, insula, thalamus and cerebellum was found, as areas responsible for sensory processing and motor-sensory integration. This pattern might be due to the fact that the brain has no information on the cause of sensory-motor mismatch. In addition, Klingner assumed that an increased amount of sensory information is important in avoiding adaptation to an impaired state of sensorimotor function and hypothesized that mirror feedback training avoids adaptation to a pathological state by additional visual information [5]. Nakamura *et al.* reported that mirror biofeedback training enabled compensation for the misdirection that occurred at the site of nerve injury, and this compensatory mechanism may be explained by either central or peripheral mechanisms [3]. At the beginning of this therapy, patients could not blink without contracting the mouth. However, after repeating this therapy several times, the patient learns to inhibit the movement of mouth while blinking. Minimal, successful movements are practiced and then progressed as success is achieved. Over time new patterns are learned and become more automatic. This process occurs through what has been called "brain plasticity", the brain's ability to modifying its organization to bring about lasting functional change [6].

According the present results, we assumed that the reinforcement of sensory information from the taped skin using this new biofeedback therapy might affect cortical plasticity and lead to functional improvements. However, little is known about the network dynamics underlying connectivity changes after biofeedback exercise with FNP. This study tried to shed light on the mechanisms underlying recovery of FNP, although further research is still needed.

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