Validation of a Treatment-Based Classification System for Individuals With Facial Neuromotor Disorders

Background and Purpose. A method for linking treatments to signs and symptoms of facial neuromotor disorders is needed. We describe the construct validation of a treatment-based classification system for facial neuromotor disorders. Subjects and Methods. Based on physical signs and symptoms, 148 patients (mean age = 48.9 years, SD = 16.1, range = 20–93) were assigned to treatment-based categories. The pattern of impairment and disability was compared with clinical expectations. Results. The distribution of impairment and disability scores demonstrated the expected signs and symptoms of the treatment-based categories. Confirmatory principal-components factor analysis indicated 4 factors, corresponding to the treatment-based categories; the factor loadings confirmed the presence of the key sign or symptom characteristic of the categories. Conclusion and Discussion. Classifying facial neuromotor disorders into treatment-based categories appears to be a valid method for categorizing patients with specific impairments or disabilities and may be useful in linking treatments to outcomes. [VanSwearingen JM, Brach JS. Validation of a treatment-based classification system for individuals with facial neuromotor disorders. Phys Ther. 1998;78:678–689.]

Key Words: Classification, Facial paralysis, Rehabilitation.

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Facial neuromuscular dysfunction is a complex disorder of the facial neuromotor system and may involve facial motoneurons and their axons, facial muscles, or connections of other brain centers with neurons in the facial nucleus in the brainstem. Disorders of the facial neuromotor system can affect an individual’s function in many ways, disrupting physical as well as psychosocial function. People with these disorders may have difficulty initiating movement, controlling abnormal movement, or relaxing muscles that are contracting involuntarily. Functional limitations such as difficulty drinking from a glass, eating, and speaking also may be present. Because of their altered appearance, many people with facial neuromuscular disorders feel uncomfortable in social situations.

Rehabilitation for facial neuromotor disorders has consisted of massage, electrical stimulation, and repetitions of common facial expressions in a general exercise regimen. This “generic” form of treatment has been found to be of little benefit. Some authors suggest that some interventions may even adversely affect recovery of facial neuromotor function, including disrupting reinnervation or result in “mass action,” a generalized contraction of all or many of the facial muscles when voluntary facial expressions are attempted.

Facial neuromuscular reeducation using surface electromyographic (EMG) biofeedback or mirror feedback is one rehabilitation technique that has been shown to lead to improvement in facial movement. Randomized clinical trials have shown that qualitative and quantitative improvements in facial movement occurred after treatment. Facial neuromuscular reeducation is a process of relearning facial movement using specific and accurate feedback to (1) enhance facial muscle activity in functional patterns of facial movement and expression and (2) suppress abnormal muscle activity interfering with facial function. The exercise program is individualized for each patient and is based on the signs of facial impairment identified and the key symptoms the patient reported at evaluation.

Although Ross et al and Segal et al reported that 2 randomized clinical trials of facial neuromuscular reeducation showed improvements after treatment, in neither of the studies did the researchers define which patients improved with what treatments, nor did the studies provide an adequate measure of treatment outcome. The outcomes are described for a homogenous group of patients when the group was most likely heterogeneous with respect to facial neuromuscular dysfunction, based on the mean and variability reported for the facial impairment measures for the samples. A homogenous group of patients in a study may result in masking differ-
Table 1. Treatment-Based Categories and Treatments Designed for Each Category

<table>
<thead>
<tr>
<th>Category</th>
<th>Signs/Symptoms</th>
<th>Treatment*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Initiation</td>
<td>Drooping brow, lowered eyelid, cheek, and corner of the mouth at rest; unable or just able to initiate muscle activity or movement, incomplete eye closure; marked physical function and psychosocial problems</td>
<td>AROM, matching movements, small range, education about the recovery process</td>
</tr>
<tr>
<td>Facilitation</td>
<td>Minimal to no drooping of the face at rest; mild to moderate facial weakness, complete eye closure; physical function problems greater than psychosocial difficulties</td>
<td>AROM, resistive exercises</td>
</tr>
<tr>
<td>Movement control</td>
<td>Eye narrowed, cheek fold deepened, corner of the mouth pulled and philtrum shifted laterally, tension at rest; mild to moderate facial weakness; abnormal movement with voluntary movement; physical function problems less than psychosocial difficulties</td>
<td>Isolated movements, correct movement patterns, stretches</td>
</tr>
<tr>
<td>Relaxation</td>
<td>Increased resting facial tension; spontaneous twitching and spasms, increasing in frequency or amplitude with increasing effort to move; few or no physical function problems; marked psychosocial difficulties</td>
<td>Rhythmic motions, relaxation exercises, stretches</td>
</tr>
</tbody>
</table>

* AAROM=active-assisted range of motion, AROM=active range of motion.

ential responses of a patient with a variety of facial movement disorders, particularly when treatments are tailored to match the signs and symptoms of the disorders. The reliability and validity of the outcome measure used by Segal et al. were not clearly described or demonstrated. In both clinical trials, the outcome was assessed using measures of the impairment of facial movement or measures reflecting pathology. No measure of disability or inventory of the patient’s experience while performing typical activities involving the face was reported.

A systematic means of defining the characteristics of a patient’s facial neuromotor disorder in multiple domains is needed, particularly for the domains of impairment and disability. A system for classifying the disorder could enhance our understanding of facial neuromotor problems and provide a framework for assessing interventions.

The purpose of classification, like diagnosis, is to ultimately impose a label on sets of signs and symptoms that implies an understanding of the conditions and treatments. A number of pathologies result in a facial neuromotor disorder. Bell palsy, primary tumors of the facial nerve, cranial-based tumors, and trauma all can lead to impairments of the facial neuromotor system. In our experience, the pathology rarely guides therapists in their interventions. For example, a patient with a 9-month history of Bell palsy may have signs of profound facial paralysis and symptoms of severe drying of the eye, or the patient may have moderate facial paresis, marked synkinesis (abnormal movements), and symptoms of excessive tearing of the eye. There also could be mild facial paresis, frequent spasms (involuntary sustained contractions) of the facial muscles, and no reported symptoms of irritation of the eye. Treatment would not be based on the pathology (Bell palsy) but rather on the (1) observed signs of resting posture changes, voluntary movement, abnormal movements accompanying voluntary movement (synkinesis), or abnormal spontaneous movements and (2) reported symptoms of difficulties in usual facial functions.

The purpose of this report is to describe an attempt to validate a classification system for individuals with facial neuromotor disorders, a system that was derived from our clinical experience in tailoring treatments based on physical signs and symptoms. By comparing the pattern of facial neuromotor impairments and disabilities, as determined with disorder-specific instruments for measuring facial impairment and disability, with our a priori clinical assumptions about the primary problems of patients classified in each of the 4 treatment categories, we provided evidence for the validity of our measure. We expected that categories based on the treatments that would be given for the physical signs and symptoms would demonstrate a specific pattern of impairments and disability characteristic of each category.

**Method**

From our experience and observations of patients with facial neuromotor disorders, we derived 4 treatment-based categories (initiation, facilitation, movement control, and relaxation), named to suggest the physical therapy tailored for the physical signs and symptoms of the category (Tab. 1). The treatments tailored for the different sets of signs and symptoms of each category were based on the rationale that the underlying neuromuscular physiology was different for each, although the pathological diagnosis may have been similar.

We theorized that patients who exhibited the ability to just barely activate facial muscles had few working facial nerve-muscle connections. Slight movement could typi-
Among the patients who demonstrated abnormal facial movement, but the movement ceased as the contralateral (uninvolved) side movement of the face exceeded the excursion of the involved side movement. We believe that a greater-than-usual resting length of the paralyzed facial muscles, due either to the effects of gravity or to the repeated activation of the uninvolved facial muscles shifting the face toward the uninvolved side, alters length-tension relationships, reducing the ease of activation of the involved facial muscles. We also believe that passively moving the face to restore the resting length often enables the patient to voluntarily initiate activity of the lengthened facial muscle. Patients with signs and symptoms of minimal facial movement and physical function improved with intervention focusing on strategies, such as the passive positioning described, for initiating facial muscle activity.

Patients who demonstrated voluntary, but incomplete, facial movement and whose involved side movement was less but did not disappear with increasing activation of the uninvolved facial muscles, improved with exercises designed to enhance facial muscle activity. Given that the patients demonstrated the ability to move in an appropriate pattern for the intended facial movement or expression, we assume they have motor programs, the set of nervous system communications for coordinating movements and postures for skillful action. According to Brooks, who described how movements are governed, repeated activation of motor programs (practice) improves learned movements.

Among the patients who demonstrated abnormal facial movements accompanying the intended voluntary movement (synkinesis), we believed the primary neurophysiological problem to be errors in recruitment, as proposed by Edgerton et al. who defined muscle dysfunction. Muscle dysfunction represents an atypical pattern of muscle activation for an intended motor task, reflecting changes in motoneuron recruitment. These patients improved facial movement when they were taught strategies for reducing abnormal movements. Those strategies included techniques for inhibiting synkinetic muscle activity, isolating the facial muscles for the intended movement, and limiting this activity to a level at which the abnormal movements did not appear. In this way, the brain has a chance to learn the identity of the facial neurons and the pattern of facial muscle activation for intended facial movements and expressions.

Patients who demonstrated abnormal, spontaneous facial muscle activity not directly associated with intended facial movements (e.g., facial muscle spasms and twitches) improved with interventions designed to enhance muscle relaxation. In patients with facial muscle activity such as spasms and twitches at rest, the neurophysiological mechanism appears to involve some instability of the activation of the facial nerves or muscles, disrupting the usual control. The experience gained through relaxation exercises of maximally contracting and relaxing the facial muscles may provide an environment in which the difference between rest and activity can be known. Presumably, the brain is then better able to attain either state voluntarily and interrupt the abnormal spontaneous facial muscle pattern of activity.

Based on our belief that certain treatments work better for some patients, we attempted to recognize the signs and symptoms of patients that were characteristic of each of the treatment-based categories. These signs and symptoms were assessed in an interview and by observation of voluntary and spontaneous facial movement patterns. Patients with the characteristic signs and symptoms described were assigned to 1 of 4 treatment-based categories representative of the physical therapy tailored for the signs of facial impairment: (1) initiation, (2) facilitation, (3) movement control, and (4) relaxation. These 4 categories are described in Table 1.

**Description of the Treatment-Based Categories**

**Initiation.** The initiation category was commonly present when there was (1) moderate to marked asymmetry of the face at rest (e.g., a drooped face, with a sagging lower eyelid, a sunken cheek, and a drooped corner of the mouth); (2) marked asymmetry with voluntary facial movement attempts (e.g., little or no ability to initiate facial movements in expressions or facial functions); and (3), rarely, abnormal movements (synkinesis). Facial expressions may be distorted, in our opinion, because the unopposed activity of the uninvolved facial muscles overpowers the muscles of the involved side. Typically, these patients have the most difficulty performing facial functions such as closing the eyes, eating and drinking, speaking, or performing oral hygiene. Marked disfigurement of the face occurs at rest and with voluntary movement, and this disfigurement usually has a major impact on the patients’ psychosocial well-being and personal and work-related interactions.

Treatment tailored for patients in this category consisted of active-assisted range-of-motion exercises and practicing facial movements in a small range. The patients were instructed to attempt to match the movement of the uninvolved side to the movement limitations of the involved side, in theory avoiding overpowering the muscle function of the involved side. The patients also appeared to benefit from education about the usual process of the recovery of facial movement and function, including expected physical signs of recovery.
Facilitation. In this category, there is (1) mild to moderate facial asymmetry at rest (eg, a slightly sagging lower eyelid, a less obvious cheek fold, a slight droop of the corner of the mouth), (2) voluntary initiation of facial muscle activity, but voluntary facial movement and expressions are mildly to moderately asymmetrical (eg, incomplete facial movements and expressions), and (3) usually little or no synkinesis. The face usually does not appear to be as severely distorted with voluntary movement as in the initiation category, with overpowering by the uninvolved facial musculature being much less of a problem. There are problems in the physical performance of facial functions such as difficulties keeping the eye closed for moistening and protection on a windy day or when washing the face. Problems with eating, drinking, and completing oral hygiene without drooling or slobbering are common, but to a lesser degree than for the initiation category. The lesser degree of resting and voluntary facial asymmetry and of physical disabilities generally appears to result in less psychosocial distress than is characteristic of the other 3 categories.

Treatment tailored for patients in this category usually did not include active-assisted exercises because the patients could initiate the movement. Active exercises and resistive exercises to increase the excursion of facial movements are, in our view, most appropriate. Patients were taught to be accurate in their performance of exercises and to be aware of some of the typical abnormal movements (synkinesis) that may develop with the increasing recovery of movement.

Movement control. Asymmetry at rest varies in this category, but some degree of asymmetry in one or more regions of the face is typical. Unlike the "drooped" asymmetry of the initiation category, the eye is often narrowed at rest by a raised lower eyelid, the cheek fold is deepened, and the corner of the mouth is pulled laterally. The cheek often appears to be raised and plumped, and the center of the lips (philtrum) can be shifted laterally toward the involved side of the face. Voluntary facial movements and expressions are decreased but not absent, as in the facilitation category. Unlike the facilitation category, facial movements and expressions are often distorted by synkinesis (eg, eye closure with a smile, retraction of the corner of the mouth and deepening of the cheek fold with a raise of the brow).

Physical performance problems are similar in function and degree to the facilitation category but, in our view, are different because of mechanisms arising largely from abnormal movement patterns, not weakness. Patients reported excessive tearing of the eye, difficulty keeping the eye open when speaking or eating, biting the inside of the cheek when eating, and speech problems when speaking quickly. Despite the usually mild resting asymmetry and some ability to voluntarily move the face, the involuntary synkinetic movements and the alteration of facial functions can be socially disfiguring and seriously disruptive to personal and work relations.

The treatment we tailored for this category involved neuromuscular reeducation techniques to help the patients learn to produce isolated muscle contractions, thus reducing abnormal movement patterns. The goal of treatment was for the patients to produce the desired facial movement patterns without the accompanying synkinetic movements. Once the patients could consistently produce correct movement patterns of facial expressions and functions, we believed that the patients were then in the facilitation category and an effort was made to increase the excursion of facial movements. For example, if the patients demonstrated symmetrical facial movement for a smile at 50% of the maximum smile on the uninvolved side, then they were encouraged to increase the intensity of effort to increase the width and breadth of the smile to 75% of maximum, all the while aiming for symmetry and without abnormal movements. Patients in the movement control category may develop a shortening of facial muscles (ie, "tightness") from the unintentional overactivation of muscles. Sustained stretching exercises of the shortened facial muscle tissues also may be indicated.

Relaxation. Individuals with facial movement disorders in this category demonstrated combinations of marked asymmetry of resting facial posture (similar to the pattern of the narrowed eye and pulling of the cheek characteristic of the movement control category) and spontaneous twitching and spasms of the facial muscles, increasing in frequency and amplitude with increasing effort to make voluntary facial movements. Although facial movement with maximal voluntary muscle contraction of the involved side is generally 50% or more than that of the uninvolved side, the usual voluntary facial movement may be moderately restricted (eg, slow and controlled, as if the patient were hesitant about moving). Observers may have the impression that the patient is unable to contract one or more of the muscles necessary for the pattern of movements of a specific facial function, such as whistling or speaking. The uncontrolled closing of the eye with ocular spasms makes some activities unsafe. Hobbies such as sewing, reading, or watching television can become intolerable, and the patient's usual facial expressions are distorted. Psychosocial problems often increase for individuals with facial twitches and spasms. These patients spend considerable energy and time trying to control their facial movements, and some patients fear that the spasm can return at any time, interfering with daily activities.
The treatment we tailored for patients in the relaxation category included active and passive exercises to achieve the primary goal of relaxation of the irritable facial motor system. Standard relaxation exercises (originally described by Jacobson\(^{36}\)) and small rhythmic, alternating movements were used to relax the facial muscles. Sustained stretching and cross-friction massage techniques were used to reduce passive tissue restrictions.

**Classification History and Examination**

The patients underwent a history and a physical examination to determine their classification into 1 of the 4 treatment-based categories. The components of the examination were divided into 3 main categories: (1) historical information, (2) assessment of resting posture (eg, position of face [anatomical landmarks of the face] under conditions in which no voluntary or elicited facial muscle activity was occurring) and voluntary movement tests, and (3) palpation tests focusing on patterns of restriction of facial muscle activity.

**History.** Patients classified into the initiation category typically reported food or drink falling from their mouth when eating or a dryness of the eye. Patients classified into the facilitation category reported similar, but milder, symptoms. For example, dryness of the eye may have occurred only if they were outside on a windy day, or they may have lost fluids from the mouth when rinsing the mouth and not necessarily when drinking from a cup. Patients classified into the movement control category reported symptoms such as the eye closing when they were eating or smiling (often first noted from photographs), tears running from the eye with attempting lip movements, and a tendency to “spit” when speaking. Incidents of biting the inside of the cheek while eating also were described. Patients in the movement control category often report that the cheek “feels tense” and that all of the symptoms have become worse since first recognized. Patients classified into the relaxation category generally reported symptoms such as pulling of the face, repeated closing of the eye, or difficulty opening the eye on the involved side. These symptoms interrupted or prevented activities such as reading, watching television, sewing, writing, or driving a car.

**Movement tests used to classify the patients.** Patients were observed with their face at rest for changes in symmetry of the face, for evidence of twitches or spasms of the facial muscles, and then for symmetry of the face with attempted voluntary movements. Patients were asked to perform facial movements or expressions and to then return to the relaxed state before being requested to repeat the facial movements or expressions. Movements were scored in 2 ways: (1) by rating the presence and amount of facial movement in the expected direction and region on the involved side compared with the uninvolved side (a measure of symmetry) and (2) by rating the presence and relative amount of abnormal (synkinetic) movements accompanying the voluntary movement and not present on the uninvolved side of the face.

**Palpation.** Muscles were palpated at rest to locate muscle spasms restricting facial motion.\(^{34}\) Areas targeted for palpation were regions of the face in which attempts at voluntary movements produced fixation of the face or movement in a direction opposite of that expected. Frequently, subtle changes in the topography of the face (eg, dimpling of the skin) are seen at rest or during movement in patients with facial neuromotor disorders, and these changes are indicative of abnormal muscle activity that may restrict the voluntary motion. For example, excessive activity of the depressor muscle group of the lower lip restricts the elevation of the corner of the mouth during smiling and results in a characteristic dimpling of the soft tissue of the chin. Passive tissue restrictions are often present in regions of the synkinetic muscle activity. For example, patients with abnormal cheek muscle contractions with lip movements during speaking or eating will not be able to “puff out the cheek” by filling the cheek with air because the cheek muscles cannot be elongated to allow for cheek expansion.

**Measurements**

**Impairment.** The Facial Grading System (FGS), designed by Ross et al,\(^{37}\) is an observer-based rating scale for measuring facial impairments. Facial impairments in 3 areas are assessed: (1) resting posture (FGS rest) of the eye, the nasolabial (cheek) fold, and the corner of the mouth, (2) voluntary movement (FGS movement) for the facial movements and expressions of forehead wrinkle, eye closure, open-mouth smile, snarl, and pucker, and (3) synkinesis (FGS synkinesis) associated with the voluntary movements tested. Scores for each of the 3 components of the scale are recorded, and the FGS rest and FGS movement scores are weighted, multiplying the component raw score by a factor of 5 and 4, respectively. The scores on the FGS rest section range from 0 to 20, and the scores on the FGS synkinesis section range from 0 to 15, with 0 representing no impairment. The scores on the FGS movement section range from 0 to 100, with 100 representing no impairment. A composite total score is calculated as follows: FGS total = FGS movement - FGS rest - FGS synkinesis. Total scores for the FGS range from 0 to 100, with overall higher scores indicating lesser impairment.

Ross and colleagues\(^{37}\) previously reported the construct validity and responsiveness of the FGS for clinically
meaningful change in patients with a facial neuromotor disorder. Adequate interrater and intrarater reliability also have been determined for the use of the scale to rate the impairment of patients with facial neuromotor disorders (intraclass correlation coefficient [ICC(2,1)] $\geq 0.90$ and 0.94, respectively).22

Disability. The Facial Disability Index (FDI) is a diseasespecific, self-report questionnaire of facial disability, with physical (FDI physical) and social well-being (FDI social) subscales.38 The FDI was developed and validated for disability associated with facial neuromotor disorders to provide an account of the patient’s daily experience while living with a facial nerve disorder. Five areas of physical performance are assessed: eating, drinking, tearing of the eye, speaking, and oral hygiene. Five areas of social well-being also are assessed: the patient’s perception of peacefulness, irritability, withdrawal, sleeping, and social activity. Each of the physical function items is scored on a scale of 0 to 5, with the highest score representing no difficulty. Each of the social well-being subscale items is scored on a scale of 0 to 6, with 6 representing no limitation in social function. Each subscale score is transformed to a score on a 100-point scale, with higher scores indicating less limitation of function. The reliability and construct validity of the FDI have been demonstrated for patients with disorders of the facial neuromotor system.38

The history, the physical examination to determine classification, and the FGS and FDI used to assess the outcome of rehabilitation for facial neuromotor disorders are typical components of the physical therapy evaluation of all patients who agree to evaluation and treatment at the Facial Nerve Center, CORE Network, Limited Liability Corporation, University of Pittsburgh Medical Center, Pittsburgh, Pa. The examination and the FGS are administered by 2 physical therapists who are experienced in the described assessment and treatment of facial neuromotor disorders. Both of the therapists had approximately 3 months of continuous experience in the evaluation and treatment of facial and nerve disorders prior to the time covered in this report. In addition, one therapist had 15 years of experience and the other therapist had 3 years of experience in diverse areas of practice prior to their involvement in the treatment of facial neuromotor disorders. The patients complete the self-report FDI prior to the examination by the physical therapists. The FGS and FDI outcome assessment measures are scored and recorded at a later time, after the examination has been completed and the treatment initiated. The examination takes approximately 20 to 30 minutes to complete.

Sample
We studied 199 consecutive, ambulatory patients with a facial nerve disorder who were referred for physical therapy evaluation at the Facial Nerve Center between August 1993 and January 30, 1997. Demographic information, history of the disorder, results of the physical examination and classification, and data obtained from the clinical assessment of impairment and disability were recorded. Patients were included in the study if they (1) had a history of a facial nerve disorder with some residual facial neuromotor impairment, (2) were 18 years of age or older at the time of the evaluation, (3) could speak and read English, (4) appeared able to follow all instructions for the physical performance and self-report assessments, and (5) had completed the assessments and had data recorded for the history, classification, and assessment measures (impairment and disability measures). One hundred fifty-eight patients met the inclusion criteria. Ten of these patients were subsequently excluded because the assessment information represented a different episode of care for a patient already included in the study. The remaining 148 patients with facial neuromotor disorders, who had completed the history, classification and impairment assessment measures, had a mean age of 48.9 years (SD=16.1, range=20–93). Of this sample, a subset of 114 patients, with a mean age of 47.6 years (SD=16.3, range=20–93), had completed the history classification and both the impairment and disability measures. The types of facial neuromotor disorders, mean ages of the patients, and durations of the disorders prior to the Facial Nerve Center evaluation are shown in Table 2.

Validity
Construct validity was determined by comparing the distribution of mean values of impairment and disability measures with our a priori expectation of the distribution of the pattern of scores across the categories. A multivariate analysis of variance (MANOVA) was used to determine whether there was an overall difference in mean scores across the groups.39 The MANOVA was followed by univariate analyses and the Scheffé test to determine whether the expected differences existed in impairment measures for the sample (n=148) or disability measures for the subset of the sample (n=114) between certain treatment categories.

Construct validity also was determined by looking at the pattern of association of impairment and disability measures indicated by component loadings on 4 factors (ie, the 4 treatment-based categories) of a confirmatory principal-components factor analysis (PCFA) with the expected signs and symptoms of each category (n=114). All statistical analyses for the determination and comparisons of group means across measures and the factor
Table 2.
Age and Duration of Disorder by Facial Neuromotor Disorder

<table>
<thead>
<tr>
<th>Facial Neuromotor Disorder</th>
<th>n</th>
<th>Age (y) X</th>
<th>SD</th>
<th>Range</th>
<th>Duration of Disorder (mo) X</th>
<th>SD</th>
<th>Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bell palsy</td>
<td>63</td>
<td>48.6</td>
<td>16.87</td>
<td>22-93</td>
<td>47.3</td>
<td>105.14</td>
<td>0.25-780</td>
</tr>
<tr>
<td>Acoustic neuroma</td>
<td>27</td>
<td>49.2</td>
<td>15.73</td>
<td>20-79</td>
<td>50.6</td>
<td>77.81</td>
<td>0.75-324</td>
</tr>
<tr>
<td>Tumor</td>
<td>17</td>
<td>53.1</td>
<td>16.60</td>
<td>24-79</td>
<td>45.6</td>
<td>71.00</td>
<td>2-288</td>
</tr>
<tr>
<td>Trauma</td>
<td>23</td>
<td>45.4</td>
<td>12.99</td>
<td>25-66</td>
<td>63.6</td>
<td>100.49</td>
<td>0.5-384</td>
</tr>
<tr>
<td>Hemifacial spasm</td>
<td>8</td>
<td>60.5</td>
<td>14.09</td>
<td>36-80</td>
<td>28.0</td>
<td>16.46</td>
<td>0.5-60</td>
</tr>
<tr>
<td>Congenital</td>
<td>5</td>
<td>33.3</td>
<td>11.64</td>
<td>20-48</td>
<td>303.6</td>
<td>225.63</td>
<td>3-600</td>
</tr>
<tr>
<td>Other</td>
<td>5</td>
<td>46.6</td>
<td>16.32</td>
<td>29-73</td>
<td>82.6</td>
<td>65.87</td>
<td>3-156</td>
</tr>
<tr>
<td>Total group</td>
<td>148</td>
<td>48.9</td>
<td>16.09</td>
<td>20-93</td>
<td>59.0</td>
<td>107.29</td>
<td>0.25-780</td>
</tr>
</tbody>
</table>

* Secondary condition; primary diagnosis at time of visit was facial paralysis for all patients.
* Includes 3 patients with Ramsay-Hunt syndrome.
* Other than an acoustic neuroma (e.g., meningioma, parotid gland tumor, primary facial nerve tumor).
* Includes 2 patients with blepharospasm.
* Vascular and other (e.g., arteriovenous malformation, Arnold-Chiari malformation, cerebrovascular accident).

Analysis were performed using SYSTAT for Windows, Version 5 (1992).*

Construct validity by comparison with impairment and disability measures. The construct validity of the treatment-based categories was determined by comparing the category assigned by the treating physical therapist with the clinical measures of impairment (FGS) and disability (FDI) for the patients in each of the treatment-based categories. We expected that the distribution of mean scores for the components of the FGS and the FDI across the 4 treatment-based categories would demonstrate the characteristics of the key signs and symptoms of each category.

We expected that patients classified into the initiation category would have the greatest abnormality in a resting posture, the least facial movement, and little or no synkinesis. We expected that physical function would be most limited in individuals with this severe lack of facial movement, as indicated by the lowest FDI physical mean score of all the treatment-based categories.

We expected that patients classified into the facilitation category would have less severe resting postural abnormalities, mild to moderate weakness, little synkinesis, and less physical and social disability than individuals in the initiation category. Thus, we expected the mean FGS rest score to be less, the mean FGS movement score to be greater, the FGS synkinesis score minimal, and the FDI physical and social well-being measures to be higher than the initiation category mean scores.

The characteristic problem of the movement control category is the presence of abnormal movements (synkinesis), which patients usually describe as socially unacceptable. We therefore expected the mean FGS synkinesis score to be greatest for individuals in this category. We also expected the mean FDI social well-being score to be lower than for the facilitation category, even though we expected that a similar level of facial movement (FGS movement) and physical function (FDI physical) would be found.

In the relaxation category, in which patients often demonstrate few resting abnormalities, minimal weakness, and few difficulties in physical function, we expected a low mean FGS rest score, a high mean FGS movement score, and a high mean FDI physical score. We expected to find intermittent spasms and facial muscle twitching, which occur unpredictably and distort the patient's appearance, seriously disrupting the patient's social interactions and feelings of well-being. We expected that these findings would be represented by the lowest mean FDI social well-being scores.

Construct validity by confirmatory principal-components factor analysis. To provide further evidence of the validity of the treatment-based categories, we performed a confirmatory PCFA to determine the correlation matrix, with number of factors set to 4 and using varimax rotation.40,41 We expected that 4 factors (corresponding to the 4 treatment-based categories) would account for the range of patterns of facial neuromotor impairment and disability of patients with a facial nerve disorder, and that the factor loadings would represent the key signs and symptoms of each of the 4 treatment-based categories, as described. We believe the use of PCFA to confirm the 4 treatment-based categories to be appropriate because the method accounts for the contribution of the components of impairment and disability to each category while demonstrating the role of impairments or
Table 3.
Scores for Impairment and Disability Measures by Treatment-Based Category

<table>
<thead>
<tr>
<th>Measure*</th>
<th>Initiation</th>
<th>Facilitation</th>
<th>Movement Control</th>
<th>Relaxation</th>
</tr>
</thead>
<tbody>
<tr>
<td>X</td>
<td>SD</td>
<td>Range</td>
<td>X</td>
<td>SD</td>
</tr>
<tr>
<td>n</td>
<td>53</td>
<td></td>
<td>17</td>
<td>65</td>
</tr>
<tr>
<td>FGS rest</td>
<td>16.7</td>
<td>3.1</td>
<td>5-20</td>
<td>12.6</td>
</tr>
<tr>
<td>FGS movement</td>
<td>32.2</td>
<td>11.2</td>
<td>20-88</td>
<td>57.2</td>
</tr>
<tr>
<td>FGS synkinesis</td>
<td>0.6</td>
<td>1.5</td>
<td>0-6</td>
<td>1.2</td>
</tr>
<tr>
<td>FGS total</td>
<td>15.0</td>
<td>12.2</td>
<td>0-73</td>
<td>42.4</td>
</tr>
<tr>
<td>n</td>
<td>36</td>
<td></td>
<td>15</td>
<td>54</td>
</tr>
<tr>
<td>FDI physical</td>
<td>62.7</td>
<td>18.2</td>
<td>30-100</td>
<td>77.5</td>
</tr>
<tr>
<td>FDI social</td>
<td>62.9</td>
<td>22.2</td>
<td>12-100</td>
<td>74.9</td>
</tr>
</tbody>
</table>

* FGS = Facial Grading System. ‡ FDI = Facial Disability Index. § Lower FGS rest and FGS synkinesis scores indicate better performance; higher FGS movement and total FGS scores indicate better performance.

† P < .01, compared with all other categories; Scheffe test, df = 3,144.
‡ P < .05, initiation compared with movement control category; Scheffe test, df = 3,110.
§ P < .05, movement control compared with relaxation category; Scheffe test, df = 3,144.

Disabilities in certain categories of treatment for facial neuromotor disorders.

Results

The distribution of mean scores for the components of the FGS measure of facial impairment and the self-report FDI measure of disability associated with a facial neuromotor disorder demonstrated the expected key signs and symptoms of each of the treatment-based categories (Tab. 3). The results of the MANOVA indicated that, overall, the impairment (Wilk's Lambda = .23; F = 31.63; df = 9,345; P = .00) and disability measures were different across the treatment-based categories (Wilk's Lambda = .81; F = 3.97; df = 6,218; P = .00). Univariate analyses indicated differences in each impairment and disability measure across the treatment-based categories, except for social disability (Tab. 3). Patients classified into the initiation category had the greatest abnormality of resting posture (mean FGS rest score = 16.7), the least voluntary facial movement (mean FGS movement score = 32.2), and little to no synkinesis (mean FGS synkinesis score = 0.6). Post hoc testing using the Scheffe test for specific between-group differences confirmed that patients in the initiation category had the greatest abnormality of resting posture and the least facial movement (Tab. 3). As we expected, these patients with severe deficits in resting facial posture and voluntary movement had the lowest mean FDI physical score (62.7) of patients in any treatment-based category, representing the difficulty in physical functions. Differences were found only between the initiation and movement control categories.

As we expected, the mean scores for impairment and disability for the patients in the facilitation category showed lesser severity of resting facial posture (lower mean FGS rest score = 13.2), fewer deficits in voluntary facial movement (greater mean FGS movement score = 57.2), and only minimal, if any, synkinesis (FGS synkinesis score = 1.2). Fewer impairments related to difficulties in physical and social functions involving the face were found for the patients in the facilitation category when compared with the patients in the initiation category. Differences in resting posture and voluntary movement between the facilitation and initiation categories and between the facilitation and movement control categories for synkinesis were confirmed by the post hoc testing (Tab. 3).

The mean scores for impairment and disability measures for the patients in the movement control category demonstrated the severity of the predominant problem of this category (ie, synkinesis). Patients in the movement control category had the greatest impairment of synkinesis compared with any of the other categories (mean FGS synkinesis score = 6.7). The Scheffe test confirmed that synkinesis was greater in this category than in the other 3 treatment-based categories (Tab. 3).

Lesser abnormality of resting posture compared with the initiation and facilitation categories and less synkinesis compared with the movement control category were found for the relaxation category, as was expected. There was a relatively higher degree of facial movement and physical function compared with all of the other categories for the patients in the relaxation category, as indicated by the distribution of the impairment and disability mean scores. The marked impact of spontaneous, unpredictable movements, such as the muscle twitching and spasms characteristic of the patients in this category, on social interactions and well-being was confirmed by the most marked social disability of all of the treatment-based categories (corresponding to the lowest mean FDI social score = 53.2).
Table 4. Confirmatory Principal-Component Factor Analysis of Treatment-Based Categories of Facial Neuromotor Disorders

<table>
<thead>
<tr>
<th>Item</th>
<th>Factor Loading*</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Initiation</td>
</tr>
<tr>
<td>FGS^rest</td>
<td>-0.954</td>
</tr>
<tr>
<td>FGS movement</td>
<td>0.367</td>
</tr>
<tr>
<td>FGS synkinesis</td>
<td>0.136</td>
</tr>
<tr>
<td>FDI^physical</td>
<td>0.049</td>
</tr>
<tr>
<td>FDI social</td>
<td>-0.042</td>
</tr>
<tr>
<td>Latent root (eigenvalue)</td>
<td>1.067</td>
</tr>
<tr>
<td>Percentage of total variance</td>
<td>21.34</td>
</tr>
</tbody>
</table>

* Factor loadings from principal-component factor analysis; rotated loadings. Shading indicates the primary contribution of impairment and disability to each treatment-based category.

The confirmatory PCFA indicated that 4 factors explained approximately 93% of the variance of the impairment and disability of patients with facial neuromotor disorders (n=114). The pattern of factor loadings of the facial impairment and disability measures on the 4 factors (corresponding to the 4 treatment-based categories) confirmed a key sign or symptom of each of the categories (Tab. 4). The factor loadings also indicated the separability of the treatment-based categories of initiation, facilitation, movement control, and relaxation, using measures of impairment and disability. Only factors with latent root values greater than 1, indicating that the factor represented a considerable component of the construct being measured (eg, facial neuromotor disorders), are shown in Table 4.

The impairment measure of resting facial posture (FGS rest) loaded most on the first factor, the initiation category. The combination of high factor loadings for movement (FGS movement) and physical disability (FDI physical) defined the second factor, the facilitation category. As we expected, the movement control category was confirmed by the key role of synkinesis, with the highest factor loadings for the measure of synkinesis (FGS synkinesis) on the third factor. The fourth factor, the relaxation category, was indicated by the highest loading for social disability (FDI social), the most noted sign of the category. The moderate loading of physical disability (FDI physical) on this factor, making the combination of physical and social disability the measures defining this treatment-based category, is in contrast to the combination of facial movement impairment and physical disability defining the facilitation category (Tab. 4).

Discussion and Conclusion

The development of a classification system based on physical signs and symptoms that enables clinicians to place patients with facial neuromotor disorders into treatment-based categories can be a first step in determining the effectiveness of physical therapy intervention for these patients.

Facial rehabilitation has often involved many repetitions of general facial movement exercises, done with little attention to the accuracy of the pattern of muscle activity or symmetry of the facial movements produced. This intervention was often reinforced by electrical stimulation into the same pattern of muscle activity. The benefits of such approaches to facial rehabilitation have not been demonstrated; thus, many authors have considered physical therapy to be no better than no intervention for the recovery of facial movement and function. The ability to tailor the physical therapy treatment for the characteristic impairments and disabilities of the facial neuromotor disorder may not only improve outcomes but also provide evidence for the cost-effectiveness of physical therapy for facial rehabilitation. If physical therapy tailored for the specific treatment-based category improves the accuracy of facial movements in facial functions (eg, eating, speech) and expressions, much secondary impairment (eg, eye irritation, dental abnormalities), disability (eg, social isolation, addiction), and handicap (eg, difficulty returning to work or personal roles) may be prevented. Some authors have described a link between facial expression, emotion, and depression, a relationship that may be influenced by the impairment of facial movement patterns as well as the social disability of facial disfigurement.

Validating the treatment-based categories by establishing the construct validity of the categories relative to measures of facial impairment and disability means that the clinical measures can be used to systematically place patients into treatment categories by use of signs and symptoms.
Patients with facial neuromotor disorders often have multiple problems in varied domains of health status (impairment, disability, handicaps). In addition, treatment for impairment of the facial neuromotor system is complicated by the difficulty of understanding the neuroscience of movement control in a system without evidence of the usual peripheral feedback (eg, few or no muscle receptors in facial muscle and no joint receptors, as there are no joints in the face proper) and by the integration of emotion and movement in facial expression. The relationship between impairment and disability is affected by psychological distress in these patients. The combination of problems can be overwhelming to the therapist (as the problems usually are to the patients themselves) and thereby disrupt or delay clinical decision making and implementation of an effective plan of physical therapy. The classification system for facial neuromotor disorders described can provide a framework for clinical decision making. We have found the system particularly helpful in educating therapists and physical therapist students regarding the care of persons with facial neuromotor disorders.

Classification into treatment-based categories can also be important in establishing the effectiveness of physical therapy for people with facial neuromotor disorders. Classification according to treatment-based categories provides a group of patients with a relatively homogenous set of signs and symptoms of a facial neuromotor disorder. Testing the effectiveness of physical therapy, relating the care the patient needs to specific outcomes, helps focus outcome research. Such classification allows for controlled clinical trials that can be conducted to compare the effectiveness of physical therapy designed for the patient with that of general exercise treatment approaches to facial rehabilitation. The ability to place patients with facial neuromotor disorders into treatment-based categories presumably can increase the quality of research.

In summary, the treatment-based classification system for facial neuromotor disorders appears to be a valid method of classifying patients based on signs and symptoms into 1 of 4 treatment-based categories. The categories represent specific patterns of facial impairment and disability for the purpose of linking specific processes of care to specific patient outcomes. The classification system is an initial step in establishing the effectiveness of tailored treatments performed by physical therapists in the rehabilitation of patients with facial neuromotor disorders.

References

Results of the confirmatory PCFA may appear slightly different than expected. Physical disability did not load on the factor representing the initiation category as expected. Instead, physical disability loaded on the factor associated with the facilitation category. Resting posture asymmetry may be such a predominant feature for describing patients in the initiation category that physical disability is not a major component of the subset of items that distinguished this category from the other treatment-based categories of facial neuromotor disorders. In multiple-factor analysis, items are rotated in search of the item or pattern of items that best describes or distinguishes each of the factors. In this case, initiation is clearly identified by the resting asymmetry, and facilitation is identified by the pattern of facial movement and physical disability.

The possibility exists that the factor loadings identified by the confirmatory PCFA represent constructs different from the treatment-based categories we defined. We believe, however, that the rotated loadings of the PCFA, in light of the unrotated loading solution, support our interpretation that the loadings demonstrate the key signs and symptoms of each of the categories. The data for the unrotated loadings (not shown) illustrated the greatest factor loadings for resting posture (-.733), voluntary movement (.841), and physical disability (.701) were all on a single factor, the initiation category.

Of the other 3 factors of the unrotated factor matrix, synkinesis primarily loaded on one factor, social disability loaded on another factor, and the last factor exhibited a pattern of weak positive component loadings for resting posture, movement, and physical disability. The component loadings of the last factor would be consistent with our original expectations for patients in the facilitation category to demonstrate less impairment and disability than patients in the initiation category. After the varimax rotation, resting posture was the key sign of the initiation category, and synkinesis was the hallmark of the movement control category. The relaxation category was most associated with social disability. The facilitation category was perhaps distinguished by the lack of marked signs of resting posture, synkinesis, or social disability, in addition to the loadings of movement and physical disability. We accepted the rotated factor-matrix solution of the PCFA because the variance explained by each factor was greater and the variation in the contribution of the components of impairment and disability to any one factor was reduced for the rotated solution.

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