Review of Objective Topographic Facial Nerve Evaluation Methods

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Objective: This study is a critical review of the described methods for objective topographic evaluation of facial nerve function to identify areas of consensus and point to future research topics. **Sources and Study Selection:** Original research articles on the subject were identified through the Medline database and reference cross-checking.

Data Extraction and Synthesis: The articles were grouped according to the methodology used for topographic facial nerve evaluation. The advantages and shortcomings of each method are evaluated. The results obtained in each publication are presented in light of the method used.

Facial neuromuscular dysfunction is, in a strict sense, an impairment of the function of the facial neuromuscular motor system. The deficits are complex but can be classified into: 1) strength deficits (e.g., impaired motion of the facial muscles); 2) motor control problems (e.g., synkinesis); 3) relaxation difficulties (e.g., contracture and spasms); and 4) psychologic issues related to the inability to express emotional mimics (1).

Evaluation of the motor facial nerve function requires that movements of the facial musculature be elicited, either by an external electrical stimulation or by a verbal command. The appreciation of these movements represents the basis of every facial nerve evaluation system. This appreciation can be divided into subjective and objective methods (Table 1).

The external electrical stimulation methods were developed in attempts to quantify the degree of Bell palsy, early in its course, and to predict patients with unfavorable outcome. Subjective methods, such as the nerve excitability threshold and the maximal stimulation test, have been superseded by objective methods, such as electroneurography. Electroneurography is seen as objective, because the response waveform can be stored and quantified and therefore has been used extensively. A detailed review of the electrical stimulation methods is beyond our scope and can be found elsewhere (2,3). **Conclusion:** Measurements localized around the facial area under investigation show maximal displacement, whereas other sites exhibit much smaller displacements. Large displacements in these locations can be used to assess synkinesis and contractures. Large intersubject variability of the same measure is found. Both linear measurement and image-subtracting techniques hold promise, but until comparative studies are performed, the best method will remain controversial. Simple systems, accurately evaluating facial motor function, are yet to be developed. **Key Words:** Facial nerve test—Objective evaluation—Review. *Am J Otol* **20**:672–678, 1999.

Electrical stimulation tests have definitive shortcomings when used in incomplete facial nerve paralysis, mainly because they lack the necessary dynamic range for quantifying the remaining facial motor function. In addition, these tests evaluate the facial nerve in its entirety and have not been applied to test the relative deficits of different facial neuromuscular territories such as smiling versus eye closure. Finally, deficits other than motor strength are not addressed by these methods. Therefore, an independent line of research in which facial movements are evoked by

voluntary contractures has emerged. In tests of facial neuromuscular function evoked by voluntary contraction, the evaluation of facial movements can be classified as subjective and objective methods (Table 1). Subjective evaluation methods correspond to the various facial nerve grading systems (4–6). Currently, the most widely used system is the House–Brackmann facial nerve grading system (HB) (5).

The scoring in the subjective facial nerve grading systems remains subjected to the variations of: 1) the adequacy of a given grading system to apprehend the facial deficit; 2) the appropriate understanding and remembering by the observer of the different grades that make up the grading system; 3) the observer's appreciation of the facial deficit; 4) the correct categorization of the deficit within a grading system; and 5) the lack of observer bias. In addition, the way the data are gathered by the observer (clinical examination, videotape, and photographs) could influence their assessment, as shown by Smith et al. (7). To palliate these inconveniences, objective methods have been proposed within the past 10 years.

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OBJECTIVE TOPOGRAPHIC FACIAL NERVE EVALUATION METHODS

TABLE 1.	Classification of facial evaluation systems according to the stimulation used to elicit
	the movement and the evaluation technique

	Facial evaluation			
Stimulus	Subjective	Objective		
Voluntary External stimulation	Facial nerve grading systems Nerve excitability threshold	Topographic tests ENoG, magnetic stimulation		
	Maximum stimulation test	-		

Objective methods use some kind of measurement techniques in the hope of reducing these errors and avoid biases in the evaluation. These objective methods could be called topographic because they evaluate the facial neuromuscular function in different facial territories. We propose to review the previously described objective topographic facial evaluation methods. According to the technique of measurement used, these methods can be subdivided into three main groups: linear measurement, image subtraction, and miscellaneous techniques.

LINEAR MEASUREMENT TECHNIQUES

In linear measurement techniques, landmarks on the face are chosen and the distances between these landmarks measured at rest and after certain facial movements. Changes in the distances between these landmarks with facial movements are taken to represent an index of the movement.

Burres' linear measurement studies

In a pioneering article, published in 1985, Burres (8) assessed "seven standard facial expressions" using linear measurements in 20 normal subjects. Marks were placed on the face with a grease pencil (Fig. 1), and measurements were taken on the patient with a hand caliper. This article provides important information on the measurements to be included in the evaluation of the specified facial movements (Table 2).

In general, the landmarks of interest for a given facial movement are located close to the facial area that is being assessed (e.g., for eye closure between SO [eyebrow] and IO [lower lid], for smiling between M [corner of mouth] and Mid [midline of the mouth]). The measurements that were selected by the author for the evaluation of the different facial movements (8,9) (Table 2) are:

- Forehead wrinkle: SO–IO; Tight eye closure: SO–IO and Na–IO (average of the two measurements)
- Nose wrinkle: Na L and Mc L (average of the two measurements); Smile: M-Mid and M-Ns (average of the two measurements)
- Kiss: M–Lc

A linear measurement index (LMi) is proposed and elaborated on in subsequent publications (10). This index was correlated with subjective facial nerve grading systems such as the one proposed by Fisch (11) and the HB scale (4,12). Unfortunately, in the calculation of this index, other measurements (corneal exposure, rest asymmetry) and somewhat involved coefficients were added. The rationale for these were never thoroughly discussed, and this global index proposed by Burres has not gained popularity. Nevertheless, the pioneer work of Burres has set the basic measurements to be looked for in an objective facial nerve evaluation system. In addition, a comparison was made with the surface electromyography, recorded over the cheek, lateral to the nasal alae. High correlation was obtained with closely related movements, such as smiling, nose wrinkling, and eye closure. Surface electromyography has been shown for some time to be proportional to the force generated by the underlying muscles (13,14), and the implications regarding the facial neuromuscular system have been discussed elsewhere (15).





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TABLE 2.	Facial	movements	and the	most	meaningful	measures	taken	(landmarks)	
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Movement	Landmarks	Average distance at rest	Right–Left difference at.rest	Average displacement	Percent displacement	Right–Left difference in displacement	Coefficient of variance
Forehead wrinkle	SO-IO	37 ± 7 mm	3%	46 mm	$24 \pm 9\%$	6%	0.38
Eyes closure, tight	SO-IO	$37 \pm 7 \text{ mm}$	3%	23 mm	$38 \pm 11\%$	6%	0.18
	Na-IO	41 ± 8 mm	6%	31 mm	$24 \pm 7\%$	6%	0.18
Nose wrinkle	L-Mc	$32 \pm 7 \text{ mm}$	5%	24 mm	$24 \pm 8\%$	5%	0.31
	L-Na	$47 \pm 9 \text{ mm}$	4%	36 mm	$23 \pm 7\%$	4%	0.45
Kiss	M-Lc	72 ± 14 mm	3%	78 mm	$8 \pm 3\%$	4%	0.34
Smile	M-Mid	28 ± 7 mm	3%	37 mm	$33 \pm 16\%$	5%	0.50
	M-Ns	39 ± 8 mm	5%	46 mm	$19 \pm 10\%$	6%	0.56

The average distance at rest is the measurement at rest between the indicated landmarks (Figure 1), averaged across the subjects. The average displacement is the measurement after the specified movement between the indicated landmarks, averaged across the subjects. The percent displacement is the change in distance divided by the rest distance \times 100. The coefficient of variance is the ratio of the standard deviation of the displacement to the mean of the displacement—it represents a comparison of the distance moved with the variation of this displacement, otherwise stated, it is the signal-to-noise ratio in the facial displacement. A low coefficient of variance represents favorable landmarks. Selected data, showing the displacements with the lowest coefficient of variation, from Tables 1 and 2 from Burres (8).

In subsequent publications (9,10), these linear measurements were applied to 44 patients with facial paralysis, the degree of which was unfortunately not specified nor stratified. Nevertheless, differences in percent displacement between the normal and paralyzed side between 10% and 25% were found.

Overall, with some improvements and digital techniques, the linear measurements and even the index proposed by Burres could become a standard tool for the objective evaluation of facial function. Unfortunately, the studies that followed used different landmarks, facial movements, and evaluation techniques.

Multicamera linear measurement studies

Frey et al. (16) used a sophisticated setup using four different cameras (Vicon; Oxford Metrics, Botley, United Kingdom). Although the authors provide few technical details in their article, the system was developed for the study of complex movements, is commercially available, and is quite sophisticated. The four cameras of the Vicon 370, probably used by the authors, are supposed to give the true three-dimensional evaluation of the movement by following 6-mm reflective marks glued on the skin. Frey et al. (16) studied 11 markings (three "fixed": tragus, chin, and central nose; eight "dynamic": upper brow, upper and lower eyelid, nasal alae, philtrum, corner and upper and lower midlateral mouth) and 10 movements somewhat different from the ones used by Burres without clearly justifying their choices.

One interesting finding of their study was the presence of static points in the face during movements: the tragus (left and right) as well as a "point over the central nose." These points did not move >1 mm during the entire session. These were therefore used as reference points. It is, however, unclear what reference was used to determine movements of these points. Otherwise, the conclusions were similar to those of Burres in that the points with maximal displacement were close to the area under study. Although no rest distances or percent displacements are provided, a second important finding in this study is that data are provided to show little displacement of facial zones away from the area under movement.

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Such systems will probably become a reference for the evaluation and comparison of simpler facial function systems, which, in turn, could be used in routine clinical practice. However, because of the cost and the time involved in facial measurements, their widespread use is improbable. Probably realizing this major shortcoming, the authors have developed a "faciometer," which is essentially a caliper with a distance readout. No comparison between the data obtained with the faciometer and the data from the Vicon measurements was provided.

Other linear measurement studies

Fields and Peckitt (17) proposed comparing the distance between the lateral canthus and the corner of the mouth at rest and during smiling on both sides of the face. A "facial nerve function index" is proposed as the ratio between the changes in distance between both sides:

$$FNFI = \frac{(D_{Rest}^{Right} - D_{Smile}^{Right})}{(D_{Rest}^{Left} - D_{Smile}^{Left})} \times 100$$

They did not state clearly how the measurement is to be performed and how much smiling is required and did not provide reference values for normal subjects or for patients with facial paralysis (17). Finding that the facial nerve function index had a skewed distribution, because of inherent intersubject facial asymmetry, additional calculations were added in a subsequent publication (18) and called the facial nerve function coefficient. The new index has a more symmetric distribution and a narrower reference range.

Murty et al. (19) proposed the so-called Nottingham system and compared it with the HB scale (5) and the index of Burres (8). The Nottingham system can be viewed as a simplification of the linear measurements of Burres (8–10): two movements (nose wrinkle and kiss) and several facial landmarks were eliminated, leaving only four marks (SO, IO, L, and M). A total score of this "linear measurement system" is a ratio of the sum of three distances (SO–IO for eyebrow rising and eye closure and Lc–M for smiling) of each side, so that 100% represents normal function and 0% represents complete paralysis. To this mini-Burres system is added the letter Y or N depending on the presence of associated deficits such as hemifacial spasm, contracture, synkinesis, crocodile tears, decreased lacrimation, and dysgeusia.

The study consisted in grading (HB scale and Burres index) the videotapes of 29 patients with various degrees of facial nerve paralysis and correlating the scores with the proposed Nottingham system. Although the three systems correlate well, the Nottingham system is preferred over the HB scale because it is continuous and it is preferred over the Burres index because it correlates better with the HB system and results in a more linear evaluation of the facial deficits.

Although the goal of this article, to derive a simplified system to be used in the clinic, is valid, there are numerous methodologic shortcomings in the article. First, whereas the title of the article states that it is an "objective assessment of facial nerve function in the clinic," it is not clear how the proposed measurements are done. Second, whereas normative data could easily be obtained by looking at Burres' publication, the authors do not provide any for their new system. Third, no test-retest or interobserver variability is shown, and therefore the reliability of this system remains unknown. Fourth, the measurement of the distances on the face of the patient (as Burres was doing) is cumbersome and prone to subjectivity and observer biases. Fifth, although a melting pot of facial nerve function criteria might initially appear attractive, it is not obvious how crocodile tears relate to the motor facial nerve function.

In 1994, Johnson et al. (20) used a linear measurement technique derived from Burres' studies. Nine points, centered around the eyes (F, Io, Na) and mouth (M, to which they added a philtrum and mentum point), are placed and five movements were requested: brow lift, tight eye closure, smile, frown, and lip pucker. Still photographs were obtained and the measures were performed by projecting the slide on a digitizer board and point coordinates obtained by pointing with a digital pen to the projected facial points.

This technique was used in seven normal subjects. A standard deviation of dot positions of 0.07 cm was found. However, the magnitude of movements among subjects was widely variable, making it difficult to assign a normal range. They stated that their assay is capable of differentiating expected movement from associated movements, that photographs are reproducible when taken on different days, and that the essay can differentiate between normal and paralyzed faces. A positive aspect allowing some normalization is the use of maximal movements that the patients were asked to sustain, and therefore the acronym MSRA (for maximal static response assay) is proposed.

El-Naggar et al. (21) described the use of photographs printed on life-size black-and-white transparency films and stated that photographs are reproducible when taken on different days. No formal description of what is evaluated on these still images is given.

Isono et al. (22) used facial markings (10 per side +4 midline) and one facial motion (eye closure). The session was taped and the tape digitized. The distance of dis-

placement was measured using an image-editing software. The reference point chosen was the nasal tip, which is probably not the best choice in view of the results of Frey et al. (16). A sort of two-dimensional x-y plot of the movements is given, but specific distances are not provided. It is not indicated whether one of these distances is more relevant than the others or whether all distances need to be evaluated. Curiously, instead of using specific points of the upper face, all displacements on each side were summed and a side-to-side ratio was obtained.

In summary, the full potential of linear measurement techniques is yet to be realized. Burres' studies provide the initial reference of measures to be studied for a given facial movement, and the nasal still point found by Frey et al. (16) could be used as a coordinate origin in further studies. If this coordinate origin can be tracked in successive videoframes by a computer system, then the distances between points as well as the changes in these distances could probably be measured. However, the technique used by most authors is manual and probably quite labor intensive. Therefore, several authors have tried to simplify the system (17-20), and digital techniques have yet to be successfully applied. There has been a general tendency to derive a number that could be used as an overall score. Although this might be useful for reporting and comparing data across studies, a single number defeats somewhat the purpose of a topographic facial evaluation technique.

IMAGE SUBTRACTION TECHNIQUES

Image subtraction techniques use digitized images and rely on a computer to perform the analysis of facial nerve function. In this technique, an initial image of the face at rest is stored and subtracted from subsequent videotape frames that are digitized. The number of pixels with different "color" in a given facial area is summed and used to calculate facial movements.

Neely and coworkers (23) have pioneered the use of digitized images for the evaluation of facial nerve function in 1992. Probably because of the size of the computer files involved in digital video, grayscale images used. According to the authors, "any area of the face that moves turns white and any of the face that has not moved zeroes out and turns black." (24). Software algorithms provide for defining areas on these facial images and counting "white" pixels within these areas. A "dynamic strength-duration curve" is generated.

In addition to the use of digital technology, other improvements include the use of a head-holder to decrease head movements during the recording session and close attention to other recording parameters such as lightening, camera-head distance, and control of head rotation (23,24). The use of such indispensable features would greatly benefit the majority of studies from other authors.

In their initial study, Neely and coworkers (23) found a large intersubject variation. In their 1994 publication (24), computer modeling attributed the majority of the variability to intersubject differences, with little test–retest variability. Although it is stated that the side of the face was also a variable, no data on this crucial point are provided.

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In subsequent publications, Neely et al. demonstrated the following:

- 1. Facial displacements detected during movements do not follow an erratic course but progress from a resting position to maximal contraction position (25).
- 2. In the analysis of facial movements, their computer system is more sensitive than naive observers (25).
- 3. The spatial resolution of their computer system is <0.1 mm (26).

Apparently, this digital technique can be used for measuring facial movements. Nevertheless, because the system has received a U.S. patent, the calculations are not discussed, and it is difficult to always determine what the authors are measuring. Finally, despite several publications, it is unclear what important features a computerized program should assess to provide a useful tool for the analysis of facial function.

Sargent et al. (27) used a regular photographic camera to obtain digital still images, which were then analyzed with commercially available software (Photoshop; Adobe Systems Inc, Mountain View, CA, U.S.A.). Only four adhesive markings were used (SO, IO, M, Lc, according to Burres' naming), and only one facial movement (smiling) was used in control subjects, whereas three movements (smiling, eye closure, and forehead wrinkling) were used in paralyzed patients. The images were manually aligned based on the corneal light reflex and the distance obtained by getting the x and y coordinates, which were entered in a spreadsheet for calculation. An image subtraction technique of grayscale images was also used and the obtained surface manually outlined for area measurements. A ratio of areas to the normal side is provided as an index to correlate with the HB and the Nottingham scales.

This technique was applied in seven control subjects and nine patients with facial paralysis. Large intersubject variability was found. The scores for the patients with paralysis correlated with the HB scale. Although the methodology of this study has numerous shortcomings, mainly related to the number of manipulations required, with inherent sources of errors and observer subjectivity at each step, this technique could be improved and automated in the future. The authors conclude that the correlation between linear measurements and area measurements is not good and, despite numerous shortcomings in their implementation of the subtraction technique, cast some doubts on the usefulness of this technique.

Meier–Gallati (28) recently used a similar technique to that of Neely et al., although they called it OSCAR, for objective scaling and area analysis. Three motions were used: smiling, eye closure, and forehead wrinkling. The face was divided into four zones on each side. Movements (both voluntary and synkinetic) were calculated as changes in the light reflection patterns within each zone. An overall index is provided, with the smile and eye closure counting as 40% each and the forehead wrinkling counting as 20%.

Scores of approximately 95% were found in 12 normal subjects, whereas patients with complete facial paralysis

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had scores of approximately 5% for smiling and forehead wrinkling. Eye closure was problematic in paralyzed patients and was therefore excluded from the computation of the index. A comparison with HB scores was given in 12 other patients with facial paralysis.

Drawbacks include the necessity of ambient luminosity control, fixed subject–camera distance, and long duration of the procedure (10 minutes). Probably the greatest problem with this method is the necessity to keep the head almost absolutely still to avoid image subtraction measurements from being erratic. To prevent this, a special head-containing device needed to be built to prevent head movements. Still, it seems quite difficult to request that a patient remain in a head restraint for 10 minutes.

In conclusion, the image subtraction method is technically difficult, requires prolonged immobility of the patient's head, and provides a difficult interpretation of the available results. The data from Neely et al. probably attest that the measurements are technically possible. Until the advent of a commercial "package" and a comparison of the various techniques, the controversy will continue. One obvious advantage is the use of area measurements rather than distance measurements as proposed by Burres and other linear measurement techniques.

MISCELLANEOUS TECHNIQUES

Ohyama et al. (29) used 19 surface electrodes to record simultaneously the EMG over the entire face. An overall score is obtained using an "interpolation formula," and scores on each side of the face were compared. They correlated these EMG scores with scores according to Yanagihara's classification (30). The technique is interesting, but was never popularized, probably because it is quite cumbersome.

Wood et al. (31) evaluated two facial movements, namely eyebrow elevation and smiling, in 11 normal subjects using microscaling. Microscaling is an analog technique allowing the placement of lines on a video screen, and the measure of the distance between these lines is provided. Practically, the videotape is stopped on an image at rest, a first line is positioned, the tape is advanced to the maximum movement frame, and a second line is placed, providing the desired lines. The distance between these lines is then measured.

Wood et al. provide data on test-retest on the same day, test-retest on different days, side-to-side, and intersubject variations. The intrasubject variability appears to be approximately 5%, whereas the intersubject variability is high, close to 25%.

There are shortcomings to this method. The requirement that the head stays in stable position relative to the camera is one shortcoming. This is almost impossible because people tend to move, rotate, and elevate the head, even when required to stay still. The element of subjectivity introduced by the observer required to judge the exact position of the facial contour that is evaluated is another shortcoming. This makes measurements around the nasal alae or in midface almost impossible. This is one of the first studies to assess test-retest variability in the evaluation of facial function. However, and because of the shortcomings of the method, we disagree with the authors' conclusion that in view of the large intersubject variability, "using objective measurements alone to follow facial palsy over time may not be valid."

Yuen et al. (32) applied moiré topography to the analysis of facial movements. The technique is not new and requires a special camera, but has the advantage of being a nontouch technique. The face is filmed and no markings are necessary. Apparently, Yuen et al. (32) used still images, which were printed for analysis. In a way, the technique remains somewhat subjective because moiré lines are counted by the observer. The authors defined "indexes" around the inner canthus, corner of mouth, and nasolabial groove. These indexes are essentially the ratio of the number of lines on the right and left sides. Apparently, these indexes are different in healthy versus paralyzed individuals; however, no cutoff limits are specified and the technique is not compared with other evaluation methods of facial function.

Although the nontouch aspect of the moiré technique is interesting and future computerized systems (the study of Yuen et al. [32] is not) might be able to provide direct counts of the number of lines, several shortcomings are inherent in the technique. Moiré lines are provided according to distances from the camera and, therefore, what can be counted are changes in this distance. How these changes in the anteroposterior dimension are related to facial movements, the majority of which are in the frontal plane, remains to be determined.

FUTURE DIRECTIONS

It is difficult to draw firm conclusions from the objective topographic methods reviewed. The topic is rather new, with almost all studies having been published during the 1990s. The best measurement technique is controversial, because comparative studies are lacking. Linear measurement methods have the advantage of simplicity and can be based on reference data. However, area measurements might be a more relevant and reliable parameter. The technique of image subtraction is elegant but seems to require elaborate illumination and patient immobilization devices to provide reliable data.

However, even if sophisticated methods have been developed, fundamental problems have still not been resolved. First, when movements are evoked by voluntary contraction, sources of error in the evaluation of facial function are related to the production of these facial movements and to the evaluation of these movements. Second, although evaluation problems have been subject to numerous studies (5,8–10,16–19,22–24,27,28,31,32), the production of facial movements has been assumed to be a reliable representation of facial nerve function. These assumptions, none of which have been formally tested, are as follows:

 The pertinent facial movements to be examined really provide an adequate representation of the facial motor function.

- 2. The patient understands the required movements and can reproduce them reliably (negligible intrasubject variability).
- 3. Variability of patient-related factors is negligible across the patient population to be evaluated (negligible intersubject variability).
- 4. The role of examiner in eliciting these movements is negligible (negligible intraobserver and interobserver variability).

An ideal objective method, in order of importance, should: 1) not impede facial movements; therefore, the face should not be touched during the movements; 2) be reproducible for a given individual, both in normal and pathologic cases; 3) provide synchronous data from the left and right sides of the face for comparison; 4) provide the measurements without touching the face; 5) provide absolute values (millimeters), not just percentages; 6) not require the observer to make the measurements, avoiding manipulation errors and bias; 7) be rapid; 8) be well tolerated by the patients; 9) be stored in some form for later comparison, evaluation by other examiners, or further studies; and 10) not require markings on the face.

Two major questions remain unanswered: what should we be measuring and how should the measurements be done? It seems clear that measurements centered around the eye are important in evaluating eye closure (8,9,16), whereas the simultaneous displacements in the perioral area are minimal (16) and could be used to evaluate secondary deficits such as synkinesis and contractures. However, the exact pertinent measures remain to be defined. Facial movements used in these topographic tests are to be standardized and clearly defined. The most often used movements are eye closure and smiling, addressing the key sphincters of the face. Although forehead and nose wrinkling and lip puckering use different facial muscles, their exact importance remains to be assessed.

In selecting the measurement method, standardized movements across subjects and across time in the same subject should ideally be relyed on. An obvious solution would be to use some form of electrical stimulation, which does not require patients' cooperation and could be easier to standardize. Although never clearly spelled out, the two stimulation methods (external electrical vs. voluntary) result in tests addressing different extremities of the facial neuromuscular dysfunction scale. The electrical stimulation tests are used for patients with little residual (0%) facial function, and voluntary-evoked movements are used for patients with good residual (100%) facial function (Fig. 2). Therefore, because of the electrophysiologic principles involved (15), it is unlikely that facial external electrical stimulation could be the answer to this standardization. Probably what needs to be standardized is the type of facial contraction requested in the voluntary contraction trials, such as the use of the maximal possible displacement for each movement (20).

Future research should be directed in two different directions. A sophisticated system could resolve the fundamental issues of the relevant measures to be used, "redefining the standard of normal and abnormal." This system can be

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elicited by verbal command

used to validate a simplified method that can be applied for routine clinical use.

Probably the only firm conclusion is that there seems to be an increasing use of digital imaging techniques. With the recent advent of commercial digital video recorders, any future system that might get widespread acceptance will be digital and use computer software to measure and calculate some form of facial function index. Whether the system can be simplified to be applied for routine clinical use remains to be seen.

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FIG.2. Classification of the stimulation methods used to elicit facial movements and their usefulness according to the degree of residual facial motor function (0-100).



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