Quantitative Analysis of Facial Motion Components: Anatomic and Nonanatomic Motion in Normal Persons and in Patients with Complete Facial Paralysis

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Numerous studies have attempted to quantify facial motion,\textsuperscript{1-6} and these authors are to be commended for addressing this complex problem. While Bajaj-Luthra et al. have introduced a new quantification method, maximal static response assay, it is important for a measure to be valid, reliable, and sensitive over the full spectrum of facial nerve recovery. Reliability of a measure would ensure that the same results are obtained when measured repeatedly and that changes in the results are due to true changes in the patient. It is necessary to establish reliability through the full spectrum of facial movement and recovery. If more than one tester is used, then another source of variability is introduced and requires the establishment of intertester reliability. Many classification systems have been described that include both subjective and quantitative assessments, yet the establishment of reliability with statistical correlational analysis is lacking.\textsuperscript{1-6} Specific to facial grading systems, it is important to determine the various factors that in combination will define facial nerve function. These properties would include resting tone and dynamic motion with consideration of both linear excursion and synkinesis. This study by Bajaj-Luthra et al. emphasizes the importance of quantification in the assessment of facial nerve function and the need for a good measure for use in clinical practice.

The House-Brackmann system consists of six grades ranging from normal movement to total paralysis.\textsuperscript{1} This scale is used widely, and its strength is in the simplicity in determining the appropriate grade. However, the scale is limited by subjective assessment and lack of quantification in determining the grade, and with the use of only six grades, it is not very sensitive. The linear measure system described by Burres and Fisch\textsuperscript{2} includes quantification of facial movement. With the use of videotapes, measurements are obtained from five standard facial expressions. By calculating the percentage displacement from a resting position, quantification of facial movement with linear excursion eliminates the bias of subjective evaluation. However, this does not include the effects of synkinesis. Frey et al.\textsuperscript{6} developed a documentation system that includes details of patient history and qualitative and quantitative assessments. A measurement method applicable for research purposes using three-dimensional videotaping is described, and recognizing the difficulty for clinical application, Frey et al. have described an instrument that can be used to quantify movement in clinical practice. They concluded that functional movements of the mouth-nose region are best determined by four exercises, including maximal teeth showing, smiling with closed lips, smiling with open lips, and lip pursing. Smile, however, is characterized best by symmetry of movement and not maximal excursion.

In this study by Bajaj-Luthra et al., the patient sample consisted of individuals with a House-Brackmann grade VI facial nerve injury, and therefore, by definition, the patients had

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no facial movement. Most grading systems that attempt to illustrate differences between patients with no movement and normal subjects will show a sharp contrast. The difficulty and challenge in a grading system are in the evaluation of patients who fall within the recovery zone of less than complete normal facial movement. The inclusion of patients with partial recovery would have added more strength to the validity of this grading system. Although the authors have differentiated between facial movements on the affected side and excursion due to movement of the contralateral side as would occur in patients with complete motor paralysis, the problem of synkinesis was not addressed in this numerical index. Initially, most patients with facial nerve injury will present with complete motor paresis, and those patients with a neuropraxic type nerve injury or a Sunderland I degree will show complete recovery within 12 weeks. The patients with Sunderland II degree injury also will regain normal facial movement, although the time for recovery will be greater than with a Sunderland I degree injury. The patients with severe injury likely will have incomplete facial motor recovery and concomitant synkinesis. In patients with recovering facial nerve injuries, weakness of the affected muscles may be present, but more problematic to normal movement is the addition of aberrant movement from muscles on the affected side. Therefore, if movement of the mouth, with use of the orbicularis oris or risorius, results in concomitant eye closure, this aberrant movement will compromise facial symmetry more than decreased excursion of the attempted movement.

With even mild synkinesis, quantification of linear excursion will give little detail regarding facial symmetry. It is therefore important to evaluate not only linear excursion but also the degree of synkinesis that may compromise facial symmetry. Since increased strength of movement also may increase the resulting synkinesis, consideration also must be given to the amount of effort being exerted (i.e., a strong pucker may cause more eye closure). A method of computerized quantitative analysis of facial motion described by Neely et al.\(^4\) permits quantitative evaluation of specific facial areas, with consideration to both excursion and synkinesis. A black-and-white videotape of voluntary facial movements is used, and the videotape is prepared for computerized digitization with a toggled stop-frame technique. The reference rest frame is subtracted from the expression frames, and the degree of differential light reflectance is recorded. A composite index can then be calculated as the sum of the restrained observation, computed curve type, and curve maximum amplitude for the three facial regions, or specific regions can be evaluated separately. Computer analysis from videotaped facial movements that digitize movement by black/gray color gradations permits unbiased quantification of both linear excursion and concomitant synkineti movements. These computerized systems, however, are costly and can be time-consuming in both collection and analysis of data. However, the need for an objective and quantifiable method of evaluation for facial nerve function cannot be underestimated, although methods that are easy to use in the clinic often lack objectivity and introduce the problem of tester bias.

Evaluation systems for facial nerve function must address not only linear excursion but also aberrant movements from synkinesis on the affected side in addition to the effect of excessive movements from the contralateral side of the face. This study by Bajaj-Luthra et al. is an important contribution in the advancement of quantitative evaluation of facial nerve function.

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