Received: 14.3.2011 **Accepted: 27.9.2011**

Original Article

Measurement of facial movements with Photoshop software during treatment of facial nerve palsy*

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Abstract

BACKGROUND: Evaluating the function of facial nerve is essential in order to determine the influences of various treatment methods. The aim of this study was to evaluate and assess the agreement of Photoshop scaling system versus the facial grading system (FGS).

METHODS: In this semi-experimental study, thirty subjects with facial nerve paralysis were recruited. The evaluation of all patients before and after the treatment was performed by FGS and Photoshop measurements.

RESULTS: The mean values of FGS before and after the treatment were 35 ± 25 and 67 ± 24, respectively ($p < 0.001$). In Photoshop assessment, mean changes of face expressions in the impaired side relative to the normal side in rest position and three main movements of the face were 3.4 ± 0.55 and 4.04 ± 0.49 millimeter before and after the treatment, respectively ($p < 0.001$). Spearman's correlation coefficient between different values in the two methods was 0.66 ($p < 0.001$).

CONCLUSIONS: Evaluating the facial nerve palsy using Photoshop was more objective than using FGS. Therefore, it may be recommended to use this method instead.

KEYWORDS: Facial Nerve Palsy, Bell's Palsy, Facial Grading System, Photoshop.

J Res Med Sci 2011; 16(10): 1313-1318

During the last three decades, various methods and instruments have been used to evaluate the paralysis of facial nerve.[1] House-Brackmann (H-B)[2] and (FGS)[3] are more popular facial grading scales being widely used to assess facial nerve palsy. The H-B grading scale was accepted in 1985 and became a standard by the facial nerve disorders committee of the American Academy of Otolaryngology-Head and Neck Surgery.[4-6] In H-B classification, which is usually used by otorhinolaryngologists, the motor function of facial nerve palsy is evaluated using six grades. Grades 1 and 6 represent normal function and complete paralysis, respectively. Grade 2 to 5 show mild to severe degrees of dysfunction and asymmetry relative to normal side.[2] it cannot be used to distinguish finer differences in facial nerve dysfunction.[7] The The FGS method, which is also called Sunnybrook Facial nerve grading system (Table 1) and was suggested by Ross et al in 1996, is more sensitive than H-B.[3] The base of this assessment is evaluating resting symmetry, degree of active and involuntary movement (synkinesis) in facial nerve pals. Overall, the assessment score is between zero (complete paralysis) and one hundred (normal) as indicated in Table1. This assessment has been successful in distinguishing between finer levels of facial nerve function before and after facial rehabilitation treatment of nerve injury and can be used order

* This article resulted from a medical research (project number: 83382)
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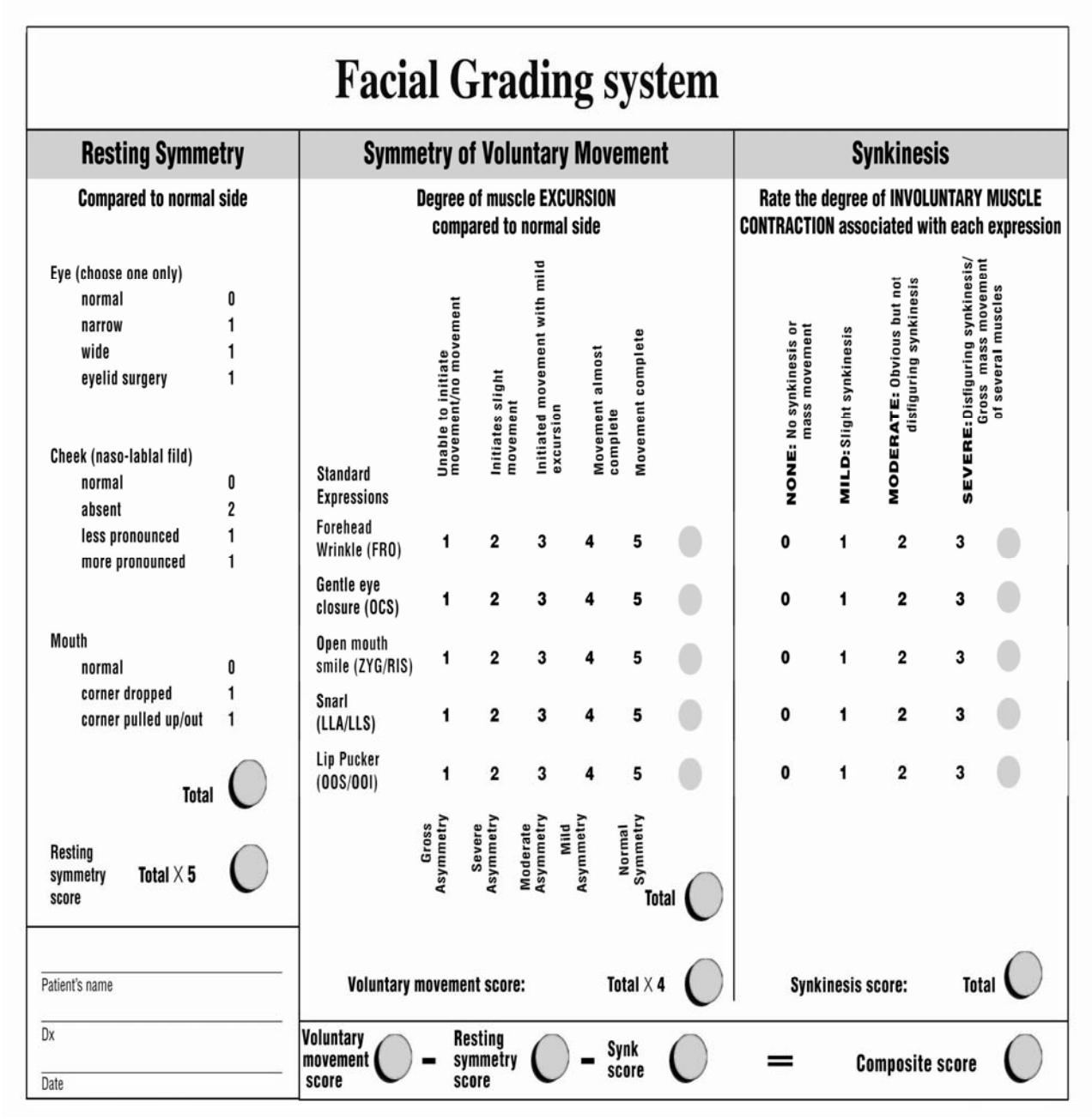
Figure 1. Facial Grading System.[21]



to monitor the recovery of patients when they receive rehabilitation treatment.[3, 8] However, both methods are subjective and all details, such as fine movements, are evaluated subjectively.[6]

In the past two decades, efforts have been made to utilize photographic techniques and computer software to find some quantitative methods revealing detailed changes sensitively.[1, 9-11] However, most of these methods either need specific skills or a software which is not accessible.[6] It seems that a computer software, such as Adobe Photoshop, would be able to quantitatively measure the function of facial nerve movement by marking the face, measuring changes of movements and comparing the difference between the two sides. This process can be performed easily and does not require experience. The aim of this study was to assess Photoshop measurements and the FGS during the rehabilitation of facial nerve palsy.

Methods

The study was designed as an open labeled clinical study using before and after intervention measurements to compare the two assessment methods. It was approved by the Regional Bioethics Committee according to national ethical codes of good clinical practice. During 4 years, all the patients who have been paralyzed for 2-3 weeks were referred from three university hospitals to our study. The main inclusion criterion for was long term rehabilitation which implies poor prognosis and gradual improvement. Therefore, we screened patients with electromyography and selected subjects with facial nerve degeneration. Exclusion criteria were neurapraxia[12] and having facial nerve palsy with upper motor neuron lesion. Forty patients with facial nerve degeneration were included in this study by standard electrodiagnostic tests. Ten patients quit due to having a surgery (myectomy), discontinuing the treatment, or changing their residence. Others were treated by a three-session per week rehabilitation program for one year. All patients were assessed before and after the treatment by two methods, namely Photoshop assessment based on a previous study[13] and FGS. In Photoshop measurements, the patients' faces were marked and digitally photographed in four different manners i.e. rest position, forehead wrinkle, snarl and smiling (showing their teeth). Pictures were transferred to a computer and vertical axes of resting photos (as the reference pictures) were determined using Adobe Photoshop. To draw the vertical axis, three points were marked on the picture including mid-point between the inside corners of the eyes, mid-point of the upper lip, and mid-point of chin. If the vertical line did not pass through these points, we tried to draw a line across the three points. The vertical line divided the face into two parts. Then, the shortest distance from the vertical line to each marker (corners of lips) was measured in the normal and impaired sides in the resting photos (Figure1). To measure the differences between the marker positions at rest and posing various facial expressions, the prepared photos showing dynamic movements (such as wrinkling, smiling, or snarling) were put on the photos prepared at rest, i.e. the unchanged parts of the face were placed exactly on their counterparts. Then, alteration of the marker positions was measured in millimeters by Photoshop. After treating, all patients were assessed by both methods. To analyze the data, paired t-test and Spearman's correlation were used in SPSS (Version 16).

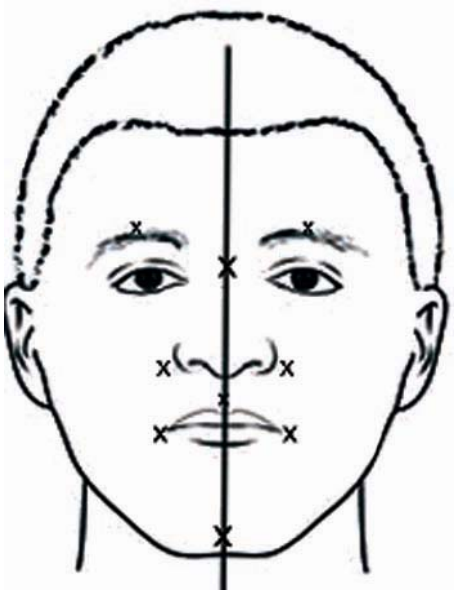


Figure 1. Marked points in Photoshop

Results

Thirty patients including 14 men and 16 women completed treatment for one year. There were 15 Bell's palsy cases, 11 trauma cases, and 4 acoustic and parotid tumor cases (Table 2).

The mean values of FGS before and after treatment were 35 ± 25 and 67 ± 24, respectively. There was a significant difference between these means ($p < 0.001$).

The mean ratio of the distance between the corner of the lip and the midline in the resting position in the impaired side compared to the sound side was 102% before the treatment and 105% after it. The mean ratio of displacement of the eyebrow in the impaired side compared to the sound side before and after treatment was 79% and 93%, respectively. The mean ratio of displacement of snarl in the impaired side in comparison with the sound side before and after treatment was 85% and 97%, respectively.

Table 2. Detailed characteristics of the patients.

Cause	
Idiopathic (n)	15
Trauma (n)	11
Tumor (n)	4 (one acoustic and 3 parotid tumors)
Gender (m/f)	16/14
Affected side (R/L)	12/18
Age	Range: 11-57 (5 patients under 20 and 7 patients older than 50 years)

after treatment was 85% and 97%, respectively. The mean ratio of the alteration of the corner of the lip in the impaired side in comparison with the sound side (by showing teeth or smiling) was 85% and 105% before and after the treatment, respectively. All the differences before and after the treatment were statistically significant ($p < 0.05$, $p < 0.001$, $p < 0.001$, and $p < 0.001$, respectively). Mean values and standard deviations are shown in Table 3.

In Photoshop assessment, the mean changes of face expression in the impaired side relative to the normal side in rest position and three main movements of face was 3.4 ± 0.55 and 4.04 ± 0.49 millimeter before and after the treatment, respectively. There was a significant difference between these means ($p < 0.001$).

Spearman's correlation coefficient between different values in the two methods was 0.66 ($p < 0.001$).

Discussion

Although H-B is a standard assessment measure, Berg et al. reported that FGS to be at the same level.[4] In the present study, we used FGS during rehabilitation treatment due to its high sensitivity to clinical changes[3] and then compared Photoshop results with FGS results. The correlation coefficient of agreement between the two methods was 0.66 which can be an appropriate coefficient factor.[14]

Although the sensory and autonomic branches of facial nerve would be damaged along with its motor branch, most assessments focused on the evaluation of motor branch (because it is the main branch).

On the other hand, it is clear that the only method of improving facial nerve palsy, in particular the cases of poor prognosis, is neuromuscular reeducation (exercise therapy).[15-18] However, the efficacy is slow and gradual.

Table 3. Mean values and standard deviations before and after the treatment.

Variable	Mean ± SD (Before treatment)	Mean ± SD (After treatment)	p-value
Facial Grading System (FGS)	35 ± 25	67 ± 24	< 0.001
The mean ratio of the distance between the impaired and sound corners of the lip (Rest position)	1.0205 ± 0.26047 (102%)	1.0590 ± 0.20438 (105%)	= 0.048
The mean ratio of contraction in impaired side of the forehead compared to the sound side (forehead wrinkle)	0.793355 ± 0.1363666 (79%)	0.938397 ± 0.1738936 (93%)	< 0.001
The mean ratio of displacement of snarl in the impaired side relative to the sound side (snarl)	0.850846 ± 0.1658078 (85%)	0.974706 ± 0.0945724 (97%)	= 0.001
The mean ratio of showing teeth in the impaired side compared to the sound side (smile)	0.850501 ± 0.2586074 (85%)	1.05559 ± 0.2169419 (105%)	= 0.001

During these improvement stages, there is a possibility to have contracture and overuse of both the impaired and normal sides causing asymmetry in the face to increase.[19] Therefore, finding a measurement tool which enables us to evaluate each part of face objectively to detect abnormalities would be of high value. The main benefit of Photoshop is that it can directly compare key points (landmarks) of the impaired side with the sound side by matching digital photos. It can also show displacements or the amplitude of muscle contraction in the impaired and sound sides. In healthy people, due to face symmetry, this ratio is equal to one.[13] However, if it is more or less than 1, analysis can reveal different states like contractures of the impaired side, muscle weakness of the impaired side, or overuse of the sound side muscles. Another benefit of this method is its ability to measure each marker individually. Each landmark, representing a group of muscles used in one of the main movements of the face, could be considered and studied separately during treatment. In addition, there is a chance to study synkinesis by this method.

Although this study was similar to Sergeant's study,[11] it is simpler, could be conducted by any version of Photoshop, and doesn't need pixel subtraction. It is also more accurate than Nottingham system[20] due to using software without requiring a manual approach which leads to more precise measurements.

Conclusions

Photoshop assessment is an accurate method for assessing face movements. By using this method, we can measure the amplitude of displacements in the main movements of the face during treatment and compare the differences with the sound side. There is also a chance to assess the severity of synkinesis.

Conflict of Interests

Authors have no conflict of interests.

Authors' Contributions

AAP suggested and carried out the design and measurements, HZ performed electrodiagnostic test and MH analyzed the data. All authors have read and approved the content of the manuscript.

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