

Facial anthropometry: a tool for quantitative evaluation in patients with peripheral facial paralysis

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Abstract— Introduction: Peripheral facial palsy (PFP) is the most frequent facial asymmetry worldwide. **Objective:** evaluate the sensitivity and specificity of the facial asymmetry method in the patients with PFP using digital clinical photographs of the face as well as CorelDraw Graphic Suite ver. 12.0 imaging software. **Materials and Methods:** Cross-sectional, descriptive and comparative study, including 46 people, 23 with PFP and 23 controls. Both groups were evaluated the facial asymmetry method. **Results:** The control group, had normal distribution with the exception of resting position, which resulted higher in men, with an average of 2.29 ± 0.53 vs. 1.72 ± 0.80 and women ($p = 0.05$), no significant differences were exhibited according to gender. The facial asymmetry method obtained an average of sensitivity of 88%, specificity of 85.3% PPV (Positive predictive value) of 85.5% and NPV (Negative predictive value) of 87.4%. **Conclusion:** The facial asymmetry method describes quantitatively and with high sensitivity and specificity small variations of facial asymmetry. This would aid the Rehabilitation Physician in designing a specific rehabilitation therapy for each patient in an objective manner, emphasizing the most affected facial area.

Index Terms--- Facial asymmetry, bilateral symmetry, facial asymmetry method, peripheral facial palsy, facial anthropometry, ROC curve

1 INTRODUCTION

The human body is characterized by having a bilateral morphology. The face is very important in individual symmetry; is a biomarker of health because is considered an indicator of developmental stability and of the individual's physiological state [1–4]. It also possesses a silent eloquence that speaks without speaking or acting; however, it exerts an effect on others [5]. The random deviations of facial symmetry are the reflection of a neuromuscular disorder created by an injury of the central or peripheral pathways of the facial nerve [4, 5]. Peripheral facial palsy (PFP) is the most common of the facial asymmetries found worldwide [6]. It reveals the control of the muscles that involve forehead, eyelids, mouth, and those that control expressions of emotions [7, 8], and when there is facial nerve damage modifies its basic functions like swallowing, talking, smile, see, as well as a deterioration in their quality of life [6-11].

In Mexico City, rehabilitation different units report that PFP occupies one of the top 10 places in medical care [7,13,14]. Its etiology could be idiopathic according to selection criteria (primary cause), or there can be a detectable cause (secondary cause)[5,7,15-17].

Campos in 2008 reported a facial asymmetry method obtained from the photography of the face in a healthy group of subjects and evaluated two types of measurements : radial proportional asymmetry (RPrAs), and angular asymmetry (AnAs), based on anthropometric points in positions two: smiling and resting, the analysis with the use of CorelDraw Graphic Suite ver.12.0 computer software [19].

In our study, we evaluated the sensitivity and specificity of the

facial asymmetry method in patients with PFP in comparison with a control group, using digital clinical photography, as well as software for images, CorelDraw Graphic Suite ver. 12.0, in four position: resting, smiling, with closed eyes, and with lifted eyebrows.

2 MATERIALS AND METHODS

2.1 Description

Cross-sectional, observational, comparative study was approved by the Ethics Committee of the National Institute of Rehabilitation (INR) in Mexico City and informed consent was obtained from all participants with the ethical norms established in the 1964 Helsinki Declaration. Forty six subjects were studied, divided into two groups: the first group was made up of 23 subjects with PFP and the second group with 23 subjects without PFP.

The Patient Group

Inclusion criteria: Patients with PFP which is basically characterized by facial asymmetry, Bell's phenomenon, retroauricular pain, epiphora. Without having received pharmacological, electrophysiological and/or facial therapy previous, maximum of 20 weeks of evolution.

Exclusion criteria: Having received facial therapy of any type, facial cosmetic surgery, or facial trauma.

The Control Group

Inclusion criteria: Persons without a history of PFP and without a history of facial cosmetic surgery.

Exclusion criteria: History of facial trauma.

2.2 Procedure for obtaining photographs

The design to obtain the photographic records was standardized. The photography was obtained placing the subject sitting down on a chair; a reference background was placed behind the subject. The camera (Sony Cyber shot 9.0 MP) was mounted on a tripod at a distance of 1.5 meters the subject and the timer and automatic function were Applied.

The head located in the Frankfort plane [20] and looking directly at the camera, with the chin in raised position. Digital photographs of the face of each subject were taken in different positions, including resting, smiling, and two additional positions were implemented: with the eyes closed, and with the eyebrows raised.

2.3 Measurement of the photographs

The photographs obtained were processed in a computer and asymmetry measurements were performed using the CorelDraw Graphic Suite ver. 12.0 software program. Two types of asymmetries were analyzed: radial proportional asymmetry (RPrAs) and angular asymmetry (AnAs). First, we drew three lines on each photography: a horizontal of bipupillary reference (HLP), and bicommissural reference (HLC), and a vertical of plane sagittal reference (VSP), and these were placed for each position [Fig. 1a], the smiling position [Fig. 1b], with eyes closed [Fig. 2a], and with eyelids lifted [Fig. 2b].

Using the following formula:

RPrAs = Pw+Fhw+Nw+Lcw+Fvw where **Pw** is bipupillary width, which is measured starting from the **VSP** to the midpoint of the pupil, **Fhw** is the facial horizontal width, measured starting from the **VSP** to the infraorbitomeatal line, **Nw** is the nasal width, measured from the **VSP** to the end of the nasal rut.

Lcw is the labial bicommissural width, measured from the

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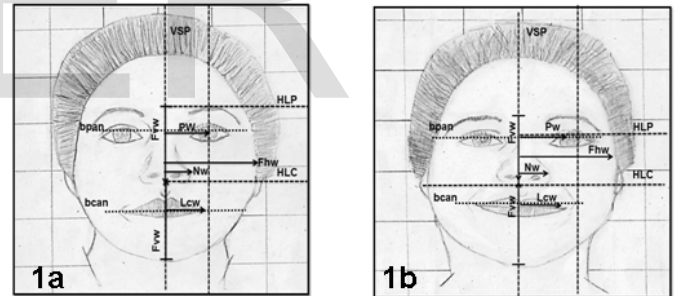
The present work was carried out at the Institute National de Rehabilitation at the Division of Rehabilitation Medicine and the Laboratory of Biochemistry.

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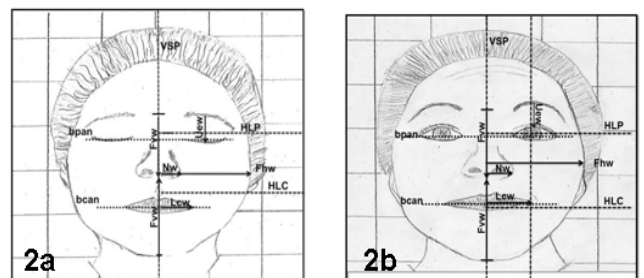
VSP to the labial commissure, **Fvw** is the facial vertical width, measured from the glabella to sub nasal and sub nasal to gnation, for positions close eyes and lifted eyebrows, and where **Uew** is upper eyelid width, measured from the mid-upper eyelid margin to the highest point of the eyebrows.

To calculate each of the left and right proportions, the lowest value is divided by the highest value. In cases in which the measurements were the same for both sides, the value obtained is one. The sum of these values should be 5; for a subject with perfect symmetry, this value decreases with increasing asymmetry. **AnAs** is determined based on the discrepancy of the horizontal facial planes measured in degrees and is obtained by adding the bipupillary angle (**bpan**) and the bicommissural (**bcan**). When there is no angle discrepancy between the left and right side, there is no measurable angle and the value is zero. We proceeded to measure each digital photo using the CorelDRAWR Graphic Suite ver. 12.0 software programs.

The average asymmetry of both groups was compared with the Student *t* test, and normality was established with the Kolmogorov-Smirnov statistical test. Sensitivity and specificity were calculated for **AnAs** and **RPrAs**. Receiver operating characteristic (ROC) was created for each position, and the cut-off point to determine highest sensitivity and specificity was identified using a statistical program, SPSS (statistical product and service solution), ver. 17 for Windows software package [21]. In all of the contrasts, the tolerance level of alpha error was 0.05.



Picture 1a and 1b: Face in resting position (1a) and smiling position (1b). **VSP:** vertical of sagittal plane reference; **HLP:** horizontal of bipupillary reference; **HLC:** Lower horizontal reference line; **Pw:** bilateral pupil width; **Fhw:** face horizontal width; **Nw:** Nasal width; **Lcw:** labial bicommissural width; **Fvw:** facial vertical width; **bpan:** bilateral pupil angle, and **bcan:** bicommissural angle



Picture 2a and 2b: Face with eyes closed (2a) and eyebrows lifted (2b). **VSP:** vertical sagittal plane; **HLP:** horizontal line of bipupillary; **HLC:** horizontal line of bicommissural; **Pw:** bipupillary width; **Fhw:** facial horizontal width; **Nw:** nasal width; **Lcw:** labial bicommissural width; **Fvw:** facial vertical width; **Uew:** upper eyelid width, **bcan:** bicommissural angle and **bpan:** bipupillary angle.

3 RESULTS

The group with 23 patients, including 11 men (47.8%) and 12 women (52.2%), with ages ranging from 22-81 years (average age, 50.43 ± 16.9 years), in which 16 patients (69.60%) were diagnosed with primary PFP, 7 patients (30.43%) had secondary PFP, 15 patients (65.21%) had PFP for the first time, and 8 patients had recurrent PFP (34.79%).

In the control group, one person was excluded because he referred facial cosmetic surgery, leaving the group with 23 healthy persons, including 14 men (60.9%) and 9 women (39.1%) between the ages of 22 and 80 years (average age, 47.65 ± 16.2 years).

According to the Kolmogorov-Smirnov test in the control group as well as in the patients group, asymmetry data exhibited normal distribution ($p = 0.5$).

RPrAs of 5 were not obtained in control group; this means that none of the faces were perfectly symmetrical. Analyzing the control group, **RPrAs** and **AnAs** had normal distribution with the exception of **AnAs** in resting position, which resulted higher in men, with an average of 2.29 ± 0.53 vs. 1.72 ± 0.80 and women ($p = 0.05$), while in the remainder of the registers no significant differences were exhibited according to gender. Another relevant aspect was that age correlated significantly with the eyes closed position of **AnAs** averages, with a Pearson's correlation coefficient of $r = 0.455$ ($p = 0.02$) and a **RPrAs** average of eyelids lifted with a Pearson's correlation coefficient of $r = 0.578$ ($p = 0.04$).

In the group of patients, normal distributions were observed in all of the measurements and with all conditions similar to those of the controlled group; **AnAs** in resting position was higher in men (with 8.82 ± 5.0) than in women (with 5.34 ± 2.65) ($p = 0.05$); age correlated significantly with **AnAs** in resting position $r = 0.480$ ($p = 0.02$), eyes closed $r = 0.442$ ($p = 0.03$), lifted eyelids $r = 0.413$, eyes closed ($p = 0.05$), and with **RPrAs** only in resting position $r = -0.487$ ($p = 0.018$); the higher the age, the higher the asymmetry.

All of the asymmetry measurement results obtained with the control group and those of the group of patients were different ($p = 0.001$) under all of the conditions. The Standard deviation (SD) of **AnAs** and **RPrAs** (Table 1), with higher **AnAs** and lower **RPrAs**, in the patient group than in the control group. Adjustment of average age as co-variant did not modify the comparisons.

Table 1. Radial proportional asymmetry and Angular asymmetry (Anas) values from the faces of 23 patients with Peripheral facial palsy (PFP) and of 23 controls ($p = 0.0001$)

Asymmetry	Positions	Patients (n = 23) average	±SD	Controls (n = 23) average	±SD
RPrAs (cm)	Resting	4.4025	0.19	4.6195	0.15
	Smiling	4.3676	0.17	4.6522	0.12
	Eyes closed	4.4065	0.24	4.5750	0.13
	Eyebrows lifted	4.2753	0.26	4.6751	0.16
AnAs (degrees)	Resting	7.1261	4.23	2.0709	0.70
	Smiling	9.6909	4.51	1.9752	1.01
	Eyes closed	9.8986	5.75	2.3065	0.96
	Eyebrows lifted	11.3704	4.48	2.9378	1.61

Data were analyzed with SPSS (statistical product and service solution), ver.17.0 for Windows statistical software

AsAn	Cut-off point (cm)	Sensitivity	Specificity	VP+	VP-	Accuracy
Resting	2.73	100.0	95.7	95.8	100.0	97.8
Smiling	4.17	95.7	95.7	95.6	95.6	95.6
Eyes closed	3.57	100.0	95.7	95.8	100	97.8
Eyebrows lifted	6.22	91.3	95.7	95.4	91.6	93.4

Table 3. Sensitivity and specificity values for Radial proportional asymmetry (RPrAs) (cm)

RPrAs	Cut-off point (cm)	Sensitivity	Specificity	VP+	VP-	Accuracy
Resting	4.587	76.2	69.6	69.5	76.1	69.5
Smiling	4.562	82.6	73.9	76.0	78.9	77.2
Eyes closed	4.495	69.6	73.9	72.7	70.8	71.7
Eyebrows lifted	4.576	87.0	82.6	83.3	86.3	84.7

Through analysis of the ROC curve for **AnAs** and **RPrAs** of the 46 patients, the values of sensitivity, specificity, positive predictive value (PV+) and negative predictive value (PV-) (Table 2 and 3).

4 DISCUSSION

The facial asymmetry method analyzes the asymmetry *per se* of patient in resting position. The face smiling, evaluates the function of the *risorius* muscle, the greater and lesser zygomatic muscle which allow the nasolabial folds move backwards.

We supplement the evaluation with the position eyes closed and eyebrows lifted: the *orbicularis oculi* eye muscle function and the eyelid elevator, in the superior palpebral opening in cm; this register is not considered in the H-B scale. The eyebrows lifted position evaluates occipitofrontal muscle function [22].

AnAs with eyes closed was higher in the control group and in patients >60 years of age. Flores et al.⁽²⁴⁾ reported that facial asymmetry increases in persons, the upper part of the face ages faster, the eyebrows descending to cover the eyelids and the expression of the eyes becomes deformed.

As previously reported by Flores et al[23], gender difference does not affect facial symmetry, because the authors observed proportions of the main facial features, which remain constant in both genders. It is noteworthy in our study that men in the control group, as well as in the patient group, in **AnAs** in resting position, showed systematically higher values than women once the influence of age and gender factors were controlled

The ROC test evaluated the accuracy diagnostic of facial asymmetry with a continuous scale method and set a cut-off point on which rests the presence of facial asymmetry and under which is rejected is their ability to differentiate between subjects symmetric versus asymmetric and compare the discriminative capacity of the method of facial asymmetry expressed with a continuous scale.

In terms of the quantitative of asymmetry in patients with PFP, this is, the first step in the contribution for having reference values with results expressed using continuous scales and for obtaining change and comparative measurements before and after physical rehabilitation as well as could be assessed the capacity of pharmacological and physical therapy. It is suggested that possible confusing variables, such as age and gender, be taken into account in future studies.

Also reduces interobserver variations without the need of being a qualifying observer. **AnAs** and **RPrAs** take the healthy side of the face as reference, and this could lead to therapy for each patient to areas that require the most attention. Implementation of this method detected positive collaboration and feedback from the patients. This is taken into consideration in conducting an evolutive study of facial therapy treatment, facial asymmetry, and its relationship with the different PFP etiologies.

5 CONCLUSION

We can conclude that the method of facial asymmetry is an easy, non-invasive, safe, fast, and reliable method that can be employed routinely in patients with PFP. It can help the physician to decide on a specific therapy directed for each patient objectively, and for the most affected region of the face. This method focuses on the evaluation of facial asymmetry. Due to the importance of the method, intends to carry out a longitudinal study during the patient's facial rehabilitation with regard to its relationship with the patient's therapy.

6 ACKNOWLEDGMENT

We are grateful to Rebecca E. Franco y Bourland, Marco Antonio Flores Mondragón, María Teresa de Jesús Baños Mendoza, Margarita Sánchez Espinosa, Julieta Flores Nava, Elihasib Rafael Herrera González, Fátima Inés Íñiguez Gómez, Jorge Campos Morales, Juan Torres Sánchez, Maggie Brunner and Violeta Ripoll.

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