Facial symmetry recovery is reduced in patients with Bell's palsy and metabolic risk factors

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Abstract— Bell's Palsy (BP) is the most common neuropathy of the facial nerve. Diabetes and hypertension are independent risk factors for developing permanent sequels. However, there is no research on the correlation between facial symmetry and metabolic risk factors in Bell's palsy. A prospective pilot observational study of patients with Bell' Palsy treated in our institution was conducted evaluating the facial asymmetry to follow-up patients' recovery. Digital photographs were recorded before and after rehabilitation in four conditions: resting, smiling, raising eyebrows, and closing eyes. Proportional radial asymmetry and angular asymmetry were measured from the images before and after rehabilitation, and its correlation with systemic arterial tension, glycemia, cholesterol, and triglyceride levels were established. Forty-two patients were included. 11.9% of patients presented diabetes and 19,0% hypertension. Significant differences ($p < 0.001$) in facial angular asymmetry, compared before and after rehabilitation for patients with high blood levels of glucose, total cholesterol, or triglycerides, were found. Less improvement in facial symmetry was significantly associated with higher glucose, cholesterol, and triglyceride blood levels. These results suggest that the method can detect minute changes in Bell's palsy patients' facial symmetry and that increased blood levels of glucose, cholesterol, or triglycerides worsen the prognosis.

Index Terms— Bell's palsy, facial symmetry, diabetes, hypertension, dyslipidemia, facial angular symmetry, facial rehabilitation.

1 Introduction

BELL'S Palsy (BP) is one of the most common mononeuropathies of the facial nerve. It is the first cause of facial nerve dysfunction attended at the Instituto Nacional de Rehabilitación Luis Guillermo Ibarra Ibarra (INRLGII). This alteration of the lower motor neuron is caused by facial nerve dysfunction and is characterized by loss of voluntary movement of muscles innervated by it. Few cases present bilateral palsy, and in some cases, it could be observed that when trying to close the eyelid, the eyeball turns upward, and the sclera could be observed (Bell's phenomenon) [1]. The disease modifies face symmetry and arises suddenly without apparent detectable cause, affecting verbal communication, facial expression, taste, and salivary gland function [2].

The psychosocial background and reluctance to deficit acceptance lead to social isolation, adversely affecting patients' quality of life [3], [4]. Independent risk factors associated with poor facial symmetry recovery are hypertension (HTN) and diabetes mellitus 2 (DM) [5], [6]. Early medical intervention, including facial rehabilitation, decreases or avoids significant and permanent sequelae [7], [8].

A diversity of clinical scales has been used to evaluate facial symmetry; none of them includes an objective measurement [9].Previously we have shown that the method of Facial Asymmetry (MFA), which uses photogrammetry to evaluate the asymmetry of the face, quantifying the radial ratio (RPrAs) and the angular symmetry of the eyes and mouth (AnAs), is an objective, straightforward method to evaluate the facial symmetry in patients with Bell's palsy [10].

As we have previously mentioned, HTN and DM affect the recovery of facial movement. However, there are no results that quantify the facial symmetry changes in patients with these comorbidities. Quantifying the changes is an essential task because it could lay the foundations for improving the quality of care and health promotion for the patients with BP from the INRLGII.

In this work, the evaluation of patients' facial asymmetry with BP through the MFA -before and after rehabilitation- was done. Its relation to high levels of blood glucose, cholesterol, and triglycerides was also investigated.

2 Methods

2.1 Ethical considerations

The research protocol was approved by the institution's ethics committee, in compliance with national and international health research laws, regulations, and standards. Written informed consent was obtained from all participants.

2.2 Clinical hystory

Initial interviews and physical examinations were done by the

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rehabilitation physicians of the service. The familiar history of HTN and DM was explicitly asked. The evolution time of HTN, DM, and BP was asked when relevant. Pharmacological and previous physical therapy were also recorded.

2.3 Study design and participants

A longitudinal prospective study was done, including patients diagnosed with BP who attended the rehabilitation service of the INRLGII.

2.4 Method of Facial Asymmetry (MFA)

Facial asymmetry was assessed by photogrammetry following a method previously described by Flores et al., 2015. Briefly, the radial proportional asymmetry (RPrAs) is defined as the ratio between left and right distances to the vertical axis, and angular asymmetry (AnAs), which is the angle between the line joining left and right anthropometric points and the horizontal axis. The selected anthropometric points were the labial commissure and exocanton on each side. Both RPrAs and AnAs were measured from digital photographs in four conditions (resting, smiling, raising eyebrows, and closing eyes). Measurements were performed before and after the rehabilitation program.

2.5 Blood sample analysis

Patients went into routine blood sample analysis before rehabilitation to detect glycemia, total cholesterol, and triglycerides, it is important to mention that 47.6% of the patients did not have glucose registered, neither 57.1% cholesterol and neither 52.4% triglycerides.

2.6 Rehabilitation program

An institutional rehabilitation program was implemented with a duration of six weeks, two sessions per day. It consisted of a morning session at the Rehabilitation Medicine service from the INRLGII and an evening session at home. During the two hours of the morning session, it was included thermotherapy, facial massage therapy, muscle rehabilitation exercises, and muscular electrical stimulation. All applied by a certified physical therapist. The evening session included home thermotherapy, and mirror mime exercises, with previous education to the patient.

2.7 Statistical analysis

Qualitative data were presented as relative frequency and quantitative with mean and standard desviation and in the case non-normally distributed median and interquartile range. The comparison of proportions was made using the Chi-square test. Comparison of means with the T-student test or one-way ANOVA. The correlation between angular asymmetry and metabolic factors was estimated with the Spearman rank correlation coefficient. All data were analyzed using SPSS17. An alpha error was set to 0.05.

3 Results

Forty-two patients with a confirmed BP diagnosis were admitted to the rehabilitation service of INRLGII. Twenty-four female (57.1%) and eighteen males (42.9%) with an average age of 49.6 +/- 15.9 years (11 - 81 years). Fasting blood glucose was greater than 110 mg/dl in 21.4%, total cholesterol ≥ 140 mg/dl in 40.5% and triglycerides ≥ 135 mg/dl in 35.7% of the patients. It is important to note that 47.6% (19), 57.1% (24), and 52.4% (22) of the patient's glucose, cholesterol, and triglycerides levels, respectively, were not recorded. The frequency of patients with DM was 11.9% (5 cases), and HTN of 19.0% (8 cases). Up to 69.0% have a family history of DM, and 45.2% of HTN. The side of the palsy was 50% right and 50% left. 92.9% of patients were right-handed.

Over one-half of patients have an evolution of the palsy of 4 weeks (59.5%) and all others between 8 to 20 weeks. Recurrent facial palsy cases were (26.2%). Only six patients (14.3%) received no pharmacological intervention, 14 (33.3%) were prescribed with oral vitamin B complex, 4 (9.5%) with oral anti-inflammatories, and 13 (31%) with both of them. Antiviral treatment was implemented in 2 (4.8%) patients receiving only vitamin B complex and 3 (7.1%) with vitamin-B + anti-inflammatories. All patients received Institutional rehabilitation (see methods).

RPrAs were calculated before and after rehabilitation in the four conditions (resting, smiling, raising eyebrows, and closing eyes). To evaluate the changes in RPrAs for each condition, two groups were formed. One group that presented RPrAs modifications after rehabilitation and another group that did not show any improvement (Table 1).

Table 1. Proportion of change (%) in each condition in RPrAs when compared before and after the rehabilitation program. Differences between groups were significant (p = 0.0001). * Two patients decreased one point.

Condition	No change group		Change group	
RPrAs Resting	32	(76.2%)	10	(23.8%)
RPrAs Smiling	27	(59.5%)*	15	(35.7%)
RPrAs R. Eyebrows	28	(66.7%)	14	(33.3%)
RPrAsClosing eyes	29	(69%)	13	(31%)

To better appreciate global change, the shift points in RPrAs for the four conditions were added. Then an improvement in radial symmetry should be understood as an increase in the total RPrAs. The results are presented in Figure 1. It can be seen that: 2.4% reduced one point, 28.6% did not present any change, 31% increased one point, 26.2% moved up two points, 9.5% three points, and 2.4% increased four points.

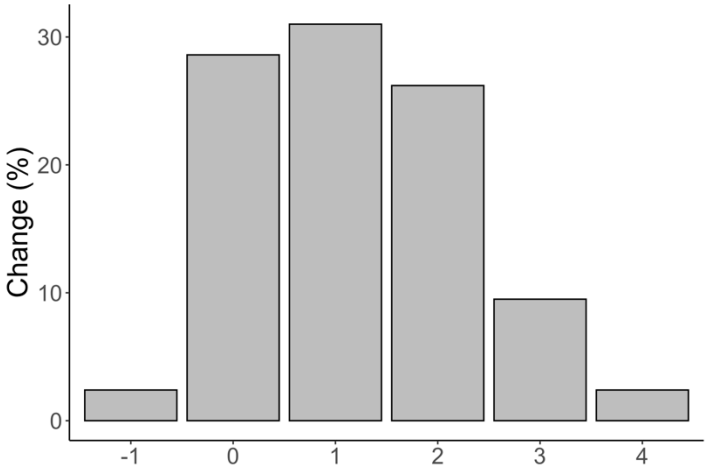

Fig. 1. Change (%) in total RPrAs compared with basal total RPrAs (before rehabilitation). Basal RPrA was a grouped in four levels from -1 to 4. * Two cases diminished one point.

The changes in AnAs are shown in Fig. 2. The proportions of changes were classified as high (9 - 12 degrees), moderate (1 - 3 degrees), or low grade (0 - 2 degrees). More remarkable changes were observed in the conditions of smiling and raising eyebrows as represented with a higher proportion of high-grade changes. The changes are best noticed in moderate-grade changes for the resting condition, and closing the eyes is characterized by the highest proportion of low-grade changes ($p = 0.0001$).

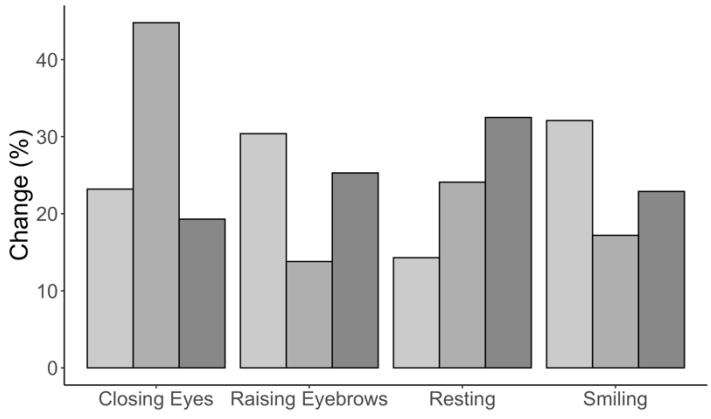

Fig. 2. Change in angular asymmetry (AnAs) after the rehabilitation program. The changes were grouped as high (9-12 degrees), moderate (1-3 degrees), and low (0-2 degrees).

Table 2. Changes in AnAs after the rehabilitation program.Intensity interval change varies in each condition ; Resting : High (-4 to -12) n = 8, Medium (-1 to -3) n = 27 Low (0-2) , Smiling : High (-5 to -11) , Medium (-2 to -4), Low (-1 to -2) , raising eyebrows High (-4 to -9) , Medium (-1 to -3) , Bass (0 to -1). %). Only the data with significant differences is presented. Alpha is fixed to 0.05.

Condition/Factors	**Low**	**Medium**	**High**	**p**
Resting				
Male Gender	7 (87.5%)	9 (33.3%)	2 (28.6 %)	0.01
Glucose > 110	0(0.0 %)	7 (25.9 %)	2 (28.6 %)	0.01
Cholesterol >140	1(12.5%)	11(40.7%)	5 (71.4%)	0.01
Triglycerides > 135	1 (12.5%)	11 (40.7%)	3 (42.9%)	0.0001
Evol.14 weeks	1 (12.5%)	18 (66.7%)	6 (85.7%)	0.007
Evol.8.20 weeks	7 (87.5%)	9 (33.3%)	1 (14.3%)	0.007
Smiling				
Age	43.3 +/- 16.0	56.1+/- 13.7	48.2+/- 16.66	**0.04**
Rising Eyebrows				
Male gender	8(61.5%)	3 (18.8%)	7 (53.8%)	0.04
Glucose > 110	0 (0%)	5 (31.3%)	4 (30.8%)	0.004
Cholesterol >140	0 (0%)	8 (50.0%)	9 (69.2%)	0.002
Triglycerides > 135	0 (0%)	7 (43.8%)	8 (61.5%)	0.001
No Treatment	0 (0%)	3 (18.8%)	3 (23.1%)	0.08
Closing eyes				
Glucose > 110	3 (17.6%)	5 (23.8%)	1 (25.0%)	0.09
Evol. 4 weeks	8 (47.1%)	13 (61.9%)	4(100%)	0.07

The results of the bivariate analysis when comparing RPrAs change with the factors were significant ($p = 0.01$) for in the number of patients without change ($n = 29$) and one point change or more ($n = 13$) the condition of closing eyes, and for the patients with controlled DM with 0 points ($n = 1$) and 1 point of change ($n = 4$) ($p < 0.01$).

In Table 2, it is shown the bivariate analysis when comparing the degree of changes in AsAn with the metabolic factors. Only significant changes are shown. When grouped in three different levels of change (high, moderate, and low), there are significant gender differences, total cholesterol (> 140 mg/dl), and triglycerides (> 135 mg/dl) in the resting and raising eyebrows conditions; in the age in the smiling condition; in evolution time in the resting and closing eyes condition; and in glycemia for resting, raising eyebrows, and closing eyes conditions.

Moreover, there exist a significant correlation between age and total RPrAs (rho coefficient = 0.334, $p = 0.03$); Diabetic patients were significant older (62.6 +/- 8.2 years) compared with non-diabetic patients (47.9 +/- 16.6 years) ($p = 0.05$). Patients that did not receive any treatment had significant lower age (38.1 +/- 15.6 years) compared with (51.6 +/- 15.3 years) those who recieved it ($p = 0.05$).

4 Discussion

Concerning the RprAs changes, at the resting condition, patients with controlled DM had significant improvements when compared with non-controlled patients, suggesting that the patients with adequate blood fasting glucose may have a better prognosis than those with poor control. These results are concordant with previous studies that show that DM is a risk factor for reduced recovery [5].

There was a decrease in the RPrAs in the smiling condition compared with age, but the results were not significant. The changes observed could be indicating that age is a risk factor for symmetry improvement; however, the results should be further explored. Even there exist results that show that facial asymmetry increases in the elderly, those results include the soft tissue changes age-related [11]. The angular asymmetry measurement is not intended to evaluate changes in connective tissue, skin color, or even hair presence, but in the changes due to muscular tone and movement. It is expected that our measure will be robust in this context.

In the closing eyes condition, the RPrAs of the group of women had better improvement. Prevalence studies have mixed results over the sex frequency presentation. It has been suggested that estrogens improve recovery after nerve damage, as shown in peripheral nerve recovery in rats, but this should also be explored further to confirm the observations [12].

The AnAs seems to be more sensitive to change than RprAs. The results show significant changes at rest when comparing the grade of change in AnAs (high, moderate, low) with most of the factors studied. The smiling condition assesses the muscular effort of the zygomaticus and risorium muscles mainly, and the raising eyebrows condition assesses frontalis muscle. Both conditions have the highest proportions of patients with changes in high grades. These changes are expected because it is known that facial recovery is present in more than 70% of patients. However, by improving the precision -with objective measurements- the recovery may be partial in most cases [13].

Notably, the recovery of symmetry in patients with controlled DM is substantially greater than that obtained in patients without DM or with uncontrolled DM. One possibility is that patients with controlled DM have better nutritional habits, which reduces oxidative stress and improves nerve recuperation [14]. Also, the initial pharmacological treatment of DM is metformin, which has been shown to improve tissue repair, although insulin also has the potential of nerve repair [15], [16].

Another possibility is that facial nerve dysfunction may be due to vascular tissue changes that are best adjusted using insulin. Kondo et al. 2012, analyzed the facial nerve of 30 cadavers and noted that the vascular system runs parallel to the facial nerve, and both pass through the facial canal, and both occupy a significant proportion of it (98%). The structures' proximity could enhance the inflammatory effect, contributing to secondary hypoperfusion and consequent ischemia and apoptosis. It is known that insulin has a protective role in vascular damage [17], [18].

Reina et al. 2000 describe that the Schwann cells have high metabolic activity. Its cytoplasm contains many dephosphorylating enzymes, and possibly after low perfusion, the alterations modify the capacity of repair of the nerve fibers [19].

Finally, most patients did not receive the recommended treatment (glucocorticoid initiation in the first 72 hours after the initial symptoms). Nevertheless, it is known that the use of glucocorticoids in non-controlled diabetic patients will raise its glycemic levels, which, as it was showed in this work, lead to unsatisfactory outcomes [20].

One limitation of the study is that almost half of the patients do not complete blood sample analysis, which is not routine in our institution. The metabolic control of the patients is done in first level hospitals. Also, the number of subjects included in the study is low. So, the power of any conclusion is subject to be confirmed.

5 Conclusions

The AnAs is an adequate measure that provided us a quantitative evaluation of facial symmetry recovery. The BP cases with low post-rehabilitation improvement in facial symmetries were significantly associated with altered glycemia, cholesterol, and triglyceride levels. These factors affect the recovery and should be considered in decision-making for the otorhinolaryngologist and rehabilitation physicians.

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