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Abstract

Background: Oro-facial myofunctional praxis assess the muscular coordination and the degree of motor impairment of the lingual, mandibular and facial muscles necessary for articulation, mimicry and swallowing.

Purpose: The objective of this study was to create and validate the MBLF protocol, a French oro-facial myofunctional assessment in order to quantify patient's impairment and to specify the motor and functional deficit for an adapted management.

Methods: The MBLF was validated against the Sunnybrook Facial Grading System (criterion validity). The construct validity was tested by comparing healthy subjects (n = 102) from patients with facial palsy (n = 60). Internal and external consistency of face symmetry were reported. Normative data was provided.

Results: There was a statistically significant correlation between the MBLF protocol and the Sunnybrook Facial Grading System ($F(59)=310.51$, $p <.001$, $R^2=.843$). Significant differences were observed in Student t-test between healthy volunteers and patients with facial palsy ($t(74.13)=14,704$, $p <.001$, $r=.863$). A significant effect of the severity grades of facial palsy on the MBLF_TOTAL scores was found ($F(158)=268.469$, $p <.001$). The more severe the facial palsy, the lower the motor scores were.

Conclusion: This MBLF French validation provides a baseline for comparing and quantifying the performance of subjects. The MBLF protocol is valid for assessing facial symmetry in peripheral facial palsy. A prospective study is needed to validate its role in dynamic evaluation of facial palsy.

Keywords: oro-facial assessment, validity, facial palsy, facial motor skills, oro-facial myofunctional

Oro-facial motor assessment: validation of the MBLF protocol in facial palsy

Oro-facial myofunctional disorder includes dysfunctions of the posture or the mobility of the face, lips, cheeks and jaws, and the tongue. It may involve isolated or combined disorders of facial motor skills, articulation and/or swallowing. The protocol of oro-facial myofunctional evaluation with scores (OMES) is validated in young and adult subjects. It is composed of an observation of the appearance and posture of the lips, mandible, cheek, tongue and palate [1]. Labial, lingual and mandibular mobility is rated on a 3-point scale, between 1 (severe inability) to 3 (normal and precise movement). The OMES protocol contributes to an overall evaluation of the motility and tone of the oro-facial muscles. However, assessment of facial action units with specific oral praxis is not provided by this protocol.

Oro-facial myofunctional assessment should be conducted in case of central and/or peripheral motor impairment. Evaluation tools dedicated to the face, the tongue or combining both exist with their own scoring process. The House and Brackmann grading scale is considered as a gold standard in the United States and Europe. It provides a 6-grade scale of severity of facial palsy evaluating global facial movements and face symmetry at rest. Grade I corresponds to normal facial motility whereas Grade VI corresponds to complete facial palsy [2]. In Japan, the Yanagihara-System scale is more widely used and analyses 10 specific movements [3]. In order to assess more precisely the facial motor skills of patients with peripheral facial palsy, the Freyss muscle test is a French test which estimates the contraction of the facial muscles [4]. It does not take into account the symmetry of the face in movement or at rest. The Sunnybrook Facial Grading System evaluate 5 facial movements, symmetry at rest and the presence of synkinesis [5]. The final composite score is between 0 and 100, where 100 corresponds to full recovery of facial function. It is calculated by subtracting the symmetry and synkinesis scores from the dynamic score [6]. Using electromyography, the frontal muscle would be an indicator of poor recovery if its percentage of degenerated fibers is greater than 50%, 3 to 7 days after the onset of facial palsy [7]. Subjective scale should therefore evaluate the entire face. Recently, the eFACE, an American clinical tool, assesses the same items and graphically represents the results using 15 visual scales [8].

Taking photographs and videos remains essential during the follow-up of patients with peripheral facial palsy. Objective measurement of smile range provides chronological feedback on the patient's progress. The MEEI

FACE-gram is a computerized program that can measure in millimeters the elevation of mouth corners, the philtrum deviation during smiling or the reduction of the lid opening during labial protrusion [9].

Facial symmetry is commonly a criterion of beauty. However, hemispheric dominance is reflected in the more prominent emotional expressiveness of the left hemi-face in right-handed subjects [10]. Furthermore, slight facial asymmetry is appreciated. Using photographic distortions in which a face is reconstructed from two identical hemi-faces (left or right), the perfectly symmetrical face has a disconcerting and unattractive effect [10]. The aesthetic and dynamic properties of the smile are well-documented [11]. Duchenne de Boulogne separates the social smile from the voluntary smile in electrophysiological studies [12]. The contractions of the orbicularis oculi sign the social and emotional aspect of the smile. Recently, Niedenthal and her team describe three different smiles with their own physiological properties: the reward smile, the affiliation smile and the dominance smile. At the opposite of the symmetric reward smile, the dominance smile is asymmetric and requires a unilateral elevation of the upper lip [13]. In patients with facial palsy (FP), the inability to smile symmetrically affect their quality of life and implies depressive symptoms [14]. According to Ishii et al., 73% of paralyzed faces at rest and 69% of smiling paralyzed faces are judged negatively. This feedback increases defensive and avoidance reactions in patients with FP [15].

Subjective measurement tools are essential to assess oro-facial functions in facial palsy. A relevant tool should assess the entire face at rest and in movement, be sensitive to change for follow-up, and be suitable for clinical assessment of the patient's quality of life [16]. To our knowledge, there is no validated and standardized French tool that determine a degree of facial symmetry and precisely assess facial, lingual and manducatory motor skills. We created the MBLF protocol (*Motricité Bucco-Linguo-Faciale* in French), an evaluation tool of oro-facial functions. The examiner express numerically on an ordinal scale his observations, so that subject comparison and follow-up monitoring could be conducted. The computerization of this protocol provides a simple and efficient scoring procedure: its duration is estimated at 10-15 min. It represents a low energy and attention cost for the patients.

In view of the need for a French valid instrument of oro-facial myofunctional assessment in adults with facial palsy, the objectives of this study were to standardized the MBLF protocol and to estimate its validity, sensitivity, specificity and consistency.

Methods

Subjects

Healthy volunteers

The normative study was conducted on 102 healthy subjects (53 women and 49 men). Recruitment was based on a voluntary basis and oral consent to participate in the research was given prior to the start of the protocol. The inclusion criteria were the following:

- adult with a good understanding of the instructions in French
- no facial deficit
- absence of botulinum toxin or hyaluronic acid using on the face.

Patients with facial palsy (FP)

The retrospective study involves the analysis of 60 medical files of patients with idiopathic peripheral FP (30 women and 30 men). The patients included in the study were treated in our ENT department. Patients with FP gave oral consent of non-opposition to the processing of their medical data. The inclusion criteria were the following:

- adults affiliated to the French social security system
- patients with idiopathic peripheral facial palsy of at least grade III with or without botulinum toxin
- as part of their clinical routine, patients who have signed an informed consent to use their image

The exclusion criteria for both groups were uncorrected sensory disturbances, central neurological history, facial transplant or facial surgery.

Material

For healthy volunteers as well as patients with FP, the MBLF protocol was carried out by two speech therapists, specialized in oro-facial myofunctional evaluation.

As a clinical routine procedure for patients with FP, the House and Brackmann grading scale, the Sunnybrook Facial Grading System and the MBLF protocol were completed in the same session by one of the speech therapist. Data was taken from their medical files.

The MBLF protocol

The MBLF protocol is used systematically in the ENT department to assess precisely facial motor skills (see appendix). It is based on the studies from the C.R.E.N.O.P.S. (Cellule de Recherche et d'Etudes Neurologiques,

Orthophoniques, Psychologiques et Sociales) [17]. It is composed of an observation of facial symmetry at rest and during a smile. Then, comprehensive evaluation of facial motility from 4 areas (eye, cheeks and mandibles, lips and tongue) is conducted. For each of these areas, the subjects were asked to perform several praxis (between 3 and 13 items) in order to assess muscle tone in different contexts and to test separate muscle groups. A computerized version is published by Adeprio Edition [18]. This software tool provides a graphical interface to visualize clinical data collected. Through recovery, follow-up profile can be made by showing longitudinal scores from precise face territories. Oral or visual instructions with photographs can be set up for patients with difficulties of sensory integration. At the end of the test, a profile is printed displaying scores and standard deviations (see appendix).

Scoring procedure

Scores are attributed using a 4-point scale: 0 = no contraction, impossibility to perform the requested movement, 1 = initiated movement, 2 = large but not sustained contraction, 3 = normal contraction. MBLF_Face sub-score is the degree of asymmetry at rest and when smiling. The scoring is carried out as follows: 0 = complete asymmetry; 1 = moderate asymmetry; 2 = mild asymmetry; 3 = complete symmetry of the face. Five sub-scores and one total score are thus obtained by adding all items: MBLF_Face (out of 6 points), MBLF_Eye (out of 9 points), MBLF_Lips (out of 27 points), MBLF_Cheeks (out of 30 points), MBLF_Tongue (out of 39 points) and MBLF_TOTAL (out of 111 points).

Medical file of patients with FP

Assessment of oro-facial motor skills includes the following tests:

- the House and Brackmann grading scale [2], which is an assessment of the severity of peripheral FP. Grade I is a normal motility whereas grade VI corresponds to complete FP.
- the Sunnybrook Facial Grading System [5], an evaluation of facial movements, facial symmetry at rest and synkinesis.
- Smile measurements using the MEEI FACEgram software [8], which provides measures of range smile in vertical, diagonal and horizontal dimensions.

Patients who underwent botulinum toxin injection, were assessed before their injections. All three scales were registered in a single session by one of the speech therapist in the ENT department.

Analysis

Analysis of criterion validity of the MBLF protocol

To determine whether the MBLF protocol really measured the parameters for which it was designed for, concurrent validity is calculated. The Sunnybrook Facial Grading System is considered as the reference test. All patients with FP were evaluated with both tests in clinical routine.

Analysis of construct validity of the MBLF protocol

The construct validity of the MBLF protocol is tested a) by comparing patients with FP (n=60) to healthy volunteers (n=102) with a statistical Student t-test; b) by analyzing the ability of the MBLF protocol to distinguish several severity grades of the House and Brackmann grading scale with an ANOVA test. Z scores were calculated according to normative data by gender and age. Raw scores and Z scores were taken into account in this analysis. The pathological threshold for Z scores was set at -1.65SD.

Analysis of sensitivity and specificity

Grades of House and Brackmann grading scale and the total score of the MBLF protocol (MBLF_TOTAL) are considered for the calculation of sensitivity and specificity through ROC curves (Receiver Operating Characteristic). We report Area Under the Curve (AUC) scores. An excellent model has an AUC near to the 1 which means it has good measure of separability.

Internal and external reliability

To provide internal consistency, we asked the same speech therapists to rate the symmetry of the face (MBLF_Face) again using patient photos. To measure external consistency, a third speech therapist also blind-assessed the MBLF_FACE with patients photos. Cronbach's α was provided for both consistencies.

Statistical analysis

Statistical analyses were conducted with open source R software and JMP.10 [19]. Regression analyses between MBLF_TOTAL scores, Sunnybrook Facial Grading System composite scores (SFGS_TOTAL) and smile measurements were also carried out. More specifically, regression analyses were conducted between MBLF_Face and SFGS_Rest which is the score of symmetry at rest. We have combined the scores of the first two movement items of the SFGS into a total score SFGS_Eye. The last three movement items were aggregated into a total score SFGS_Lips. Then, scores of MBLF_Eye were compared to SFGS_Eye and scores of MBLF_Lips were compared to SFGS_Lips.

Pearson's correlations were estimated. One-factor ANOVAs were carried out to determine potential effect of age or severity grade of FP on MBLF scores. Student t-tests were performed to determine differences between men and women.

Results

Subjects

Healthy volunteers

Normative population was composed of healthy volunteers: 53 women and 49 men. The population was divided into 6 age groups:

- 20-29 (9 women and 7 men)
- 30-39 (10 women and 8 men)
- 40-49 (9 women and 9 men)
- 50-59(9 women and 9 men)
- 60-69 (8 women and 8 men)
- over 70 years old (8 women and 8 men)

Patients with FP

Sixty patients with FP were included in the study: 30 women and 30 men with House and Brackmann grades between III and V:

- Grade III: 10 men and 10 women who did not receive botulinum toxin and 10 men and 10 women who received botulinum toxin as part of the treatment of the sequelae of FP.
- Grade IV and V: 10 men and 10 women.

No Grade II nor Grade VI were included because of recruitment bias.

Normative study of the MBLF protocol

Gender effect

In the normative population, labial motility was significantly higher in women. Indeed, lip motility reached 99.37% in women and 97.58% in men ($t(63,72)= 2.439$, $p=.018$, $r=.292$).

Age effect

An age effect was found on the MBLF_TOTAL scores ($F(96)=2.867$, $p=.019$). Scores of subjects over 60 years old were significantly lower than scores of subjects between 30 and 59 years old.

Normative data

Normative data were reported according to the age and gender of healthy subjects (Table 1). Mean and standard deviations were provided not only for each sub-score but also for the MBLF_TOTAL score.

Criterion validity of the MBLF protocol

To test the internal validity of the tool, we found a positive correlation between the MBLF_TOTAL scores and the composite score of the Sunnybrook Facial Grading System (SFGS_TOTAL). The total scores of the two scales followed the same trajectory as shown in Figure 1 ($F(59)=310.51$, $p <.001$, $R^2=.843$). More specifically, MBLF_Face and SFGS_Rest were negatively correlated ($F(59)=23.78$, $p <.001$, $R^2=.291$). Positive correlation were found between MBLF_Eye and SFGS_Eye ($F(58)=171.06$, $p <.001$, $R^2=.750$) and between MBLF_Lips and SFGS_Lips ($F(58)=237.94$, $p <.001$, $R^2=.807$).

Furthermore, regression analyses indicated a positive correlation between the subjective rating of the MBLF_TOTAL score and the objective measures of smile. As the MBLF_TOTAL scores increases, paralyzed corner of the mouth rises vertically ($F(59)=36.628$, $p <.001$, $R^2=.387$), diagonally ($F(59)=51.632$, $p <.001$, $R^2=.471$) and horizontally ($F(59)=34.763$, $p <.001$, $R^2=.375$).

Construct validity of the MBLF protocol

The ability of the MBLF protocol to reflect normal and FP oro-facial functions was demonstrated by the significant differences observed in Student t-test between healthy volunteers and patients with FP ($t(74.13)=14,704$, $p <.001$, $r=.863$). Z scores ranged from -0.50 to -49.33. According to the pathological threshold, 93% of patients had pathological scores in relation to their gender and age groups.

The MBLF protocol separated severity grades of FP. Indeed, significant effect between House and Brackmann grades and the MBLF_TOTAL scores were reported ($F(158)=268.469$, $p<.001$) (Figure 2). Using Z scores, severity grade effect was also observed on MBLF_TOTAL scores (Chi Square = 11.91, df=2; p=.0026)

For each sub-score, except for MBLF_Tongue sub-score, there is a significant effect of House and Brackmann grade on motor skills (Figure 3). The more severe the facial palsy, the lower the scores are:

- MBLF_Face: $F(158)=378.648$, $p<.001$, $R^2=.878$;
- MBLF_Eye: $F(158)=334.832$, $p<.001$, $R^2=.864$;
- MBLF_Lips: $F(158)=629.616$, $p<.001$, $R^2=.923$;
- MBLF_Cheeks: $F(158)=10.838$, $p<.001$, $R^2=.283$;
- MBLF_Tongue: not significant

Sensitivity, specificity and ROC Curves

By analyzing the ROC curve of the MBLF_TOTAL score with severity grades of House and Brackmann grading scale (Figure 4), areas under the curve confirmed the high sensitivity of the MBLF protocol: AUC(Grade III) =.972; AUC(Grade IV) =.990; AUC(Grade V) = .996

Internal and external validation

Intra-rater assesments of MBLF_Face using photos were highly reliable (Cronbach's $\alpha = .914$). Inter-rater reliability was also strong (Cronbach's $\alpha = .938$).

Discussion

The House and Brackmann grading scale assess global facial tone and motility in a 6-grade scale. It is considered as gold standard for facial palsy (FP) assessment in the United States and Europe [6,9,20].

According to Peitersen in 2002, 70% of patients with FP recover spontaneously within 6 months. The remaining 30% have sequelae such as synkinesis, contractures and hemi-spasm [21- 22]. The severity of FP at the acute stage is a prognostic indicator of long-term recovery [20, 21]. Indeed, the recovery rate in patients with incomplete palsy is significantly better than in patients with complete palsy [20]. Furthermore, a grade between IV and VI at 1 month after the onset of FP is a poor prognostic factor [20]. It is therefore relevant to obtain a precise, standardized and quantified evaluation at the acute stage of the FP but also at the follow-up stage in order to assess the evolution of facial skills.

The Sunnybrook Facial Grading System developed by Ross et al., in 1996, is used as a prognostic factor for recovery [5, 6]. Bylund et al., reported that a composite SFGS_TOTAL score of less than 70% at 1 month from the onset of FP could predict a risk of non-recovery at 12 months [6]. Follow-up assessment up to 12 months is relevant to understand comprehensively the outcome of the sequelae, as the severity of synkinesis may increase between 6 and 12 months [6]. Moreover, scores on the movements "smile with open mouth" and "soft eye closure" of the Sunnybrook Facial Grading System at 1 month are the best predictors of synkinesis at 12 months [6]. Thus, some areas of the face would have greater sensitivity than the others to predict recovery, which enhance our objective of a standardized tool with region-specific scores.

Banks et al., created an American tool named eFACE in 2015 [7]. It evaluates facial symmetry at rest and in motion as well as synkinesis. Fifteen visual scales compose this assessment tool. Each scale includes a score ranging from 0 (total asymmetry, lack of movement or severe synkinesis) to 100 (normal functions, total symmetry or lack of synkinesis). Some items up to 200 in order to evaluate when the nerve recovers with too much force. Like the Sunnybrook Facial Grading System, the authors report high sensitivity of the eye and smile regions to predict recovery [7].

To our knowledge, there is no validated and standardized French tool that determine a degree of facial symmetry and precisely assess facial, lingual and manducatory motor skills. Thus, we created the MBLF protocol (*Motricité Bucco-Linguo-Faciale* in French) to assess oro-facial functions in healthy subjects and patients with FP. Baseline and follow-up evaluation can be reported on an ordinal scale in order to monitor numerically the evolution of FP. The objectives of this study were to standardize the MBLF protocol and to analyze its validity, sensitivity and specificity.

First, we provided normative data of the MBLF protocol according to age and gender of the healthy volunteers (n=102). Age effect on the oro-facial motor skills was found in the normative data since MBLF_TOTAL scores were significantly lower for subjects overs 60 years old. The tone of the cheek tends to decrease in elderly adults because of soft tissue aging or changes in the stomatognathic system [23]. Studies attest that facial asymmetry increases with age [24]. No significant differences are found in the MBLF_Face symmetry sub-score between age groups of the normative study.

An instrument for diagnostic measurement must be analyzed in terms of criterion and construct validity. The Sunnybrook Facial Grading System is used as the reference test in this study (SFGS). All patients with FP were

evaluated with the MBLF protocol and the Sunnybrook Facial Grading System during a same session. Internal validity of the MBLF protocol is approved since a strong correlation was reported between both tests. MBLF_TOTAL scores and the composite score of the Sunnybrook Facial Grading System followed the same trajectory. Moreover, the sub-scores of the MBLF (MBLF_Rest, MBLF_Eye and MBLF_Lips) were each correlated with the sub-scores of the SFGS (SFGS_Rest, SFGS_Eye and SFGS_Lips).

Construct validity of the MBLF protocol was analyzed by comparing patients with FP to healthy volunteers. The MBLF protocol can differentiate normal facial motor skills and FP. We confirm construct validity by analyzing the effect of severity grades on MBLF_TOTAL scores. Indeed, both the raw scores and the Z score of MBLF_TOTAL were significantly different from one grade to another. The MBLF protocol is specific and can objectify the deficit from different face areas as show by the effect of the severity grade on MBLF_Face, MBLF_Eye, MBLF_Lips and MBLF_Cheeks. The MBLF protocol is an excellent model to determine severity of FP since Areas Under the Curves provided in ROC curves has good measure of separability. One of the limitations of our study is the non-inclusion of patients with grade II and grade VI. Indeed, this is a retrospective study based on patients' medical files and photographs. It is rare for the speech therapists to assess patients in the very acute phase: the patients have already reached grade V at the time of assessment. On the other hand, patients with grade II, who are satisfied with their recovery, no longer came to the hospital for further rehabilitation. Assessments are then not easily available since grade II patients are usually lost to follow-up.

In this study, the MBLF protocol is used with patients at various stages of recovery. The MBLF_Face sub-scores, composing of two items (symmetry of the face at rest and in movement), differentiates healthy volunteers (Grade I) from patients with severe FP of Grade V. The scores of control subjects range from 4 to 6 points, while patients with grade V or higher have scores between 0 and 3 points. Retrospective reliability was measured with photos of patients available with their medical files. Pictures were taken into consideration only for validation of the static symmetry to avoid further bias. Although the retrospective design itself may bring some bias, strong internal consistency was found (Cronbach's $\alpha = .914$). Furthermore, blind inter-rater validation was also consistent (.Cronbach's $\alpha = .938$). The MBLF protocol is valid for assessing facial symmetry in peripheral facial palsy. A prospective study would enable to measure the internal and external consistency of the tool on dynamic movements. In order to understand the severity of the impairment, it is necessary to assess both the symmetry of the face at rest and in movement and to quantify the motor skills of each facial region.

The MBLF protocol does not directly include facial synkinesis in the assessment. Indeed, it was created to evaluate oro-myo-facial functions in the context of various pathologies such as dysarthria, ataxia [25], sleep apnoea, central or peripheral facial paralysis. Synkinesis were indirectly studied since they impaired the symmetry of the face (MBLF_Face) and limited the movements observed (MBLF_Eye, MBLF_Cheeks, MBLF_Lips) because of simultaneous involuntary contractions. In clinical routine, we qualitatively annotate on the scale the presence of synkinesis and their location.

Lingual motility is logically spared given its innervation by the hypoglossal nerve. The MBLF_Cheeks sub-score is significantly different between grades. Nevertheless, it is not the most decisive sub-score in the evaluation of FP. Indeed, this sub-score is composed of both facial muscle items and items associated with mandibular movements. In cases of complete facial palsy, rehabilitation techniques such as hypoglosso-facial anastomosis, temporal lengthening myoplasty or massetero-facial anastomosis may be proposed [26]. In these cases, it is necessary to measure lingual and masticatory motor skills prior to the operation and during follow-up [26].

From an embodied perspective, this new tool also provide to quantify precisely facial motor skills in order to better understand the subjective feelings of the subject and emotional, cognitive and physiological reactions. Indeed, in a communication situation, the subject's emotional contagion and physiological responses evolve according to the type of smile observed in others [13].

Conclusion

Based on the present results, the MBLF protocol is valid for the assessment of facial symmetry in adults subjects. It differentiates healthy volunteers from patients with facial palsy. It separates severity grades of facial palsy. A prospective study is needed to validate its role in dynamic evaluation of facial palsy. It can be useful both in clinical practice and in rehabilitation research.

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Table

Table 1. Normative data of each sub-scores of the MBLF protocol and MBLF_TOTAL scores (mean and standard deviation SD)

Gender	**Women**						**Men**					
Age	**20-29**	**30-39**	**40-49**	**50-59**	**60-69**	**70+**	**20-29**	**30-39**	**40-49**	**50-59**	**60-69**	**70+**
	Mean (SD)	Mean (SD)	Mean (SD)	Mean (SD)	Mean (SD)	Mean (SD)	Mean (SD)	Mean (SD)	Mean (SD)	Mean (SD)	Mean (SD)	Mean (SD)
MBLF_Face	6,00 ()	6,00 ()	6,00 ()	6,00 ()	6,00 ()	6,00 ()	5,71 (0,76)	6,00 ()	6,00 ()	6,00 ()	6,00 ()	6,00 ()
MBLF_Eye	8,89 (0,33)	9,00 ()	9,00 ()	9,00 ()	8,88 (0,35)	9,00 ()	8,71 (0,76)	9,00 ()	8,89 (0,33)	8,89 (0,33)	9,00 ()	9,00 ()
MBLF_Lips	27,00 ()	26,90 (0,32)	26,89 (0,33)	26,67 (1,00)	27,00 ()	26,50 (0,76)	26,14 (1,46)	26,75 (0,71)	26,44 (0,88)	26,78 (0,44)	25,75 (2,38)	26,13 (1,13)
MBLF_Cheeks	29,78 (0,67)	28,50 (2,12)	30,00 ()	28,22 (3,96)	25,75 (5,28)	24,50 (5,10)	24,43 (7,02)	30,00 ()	29,00 (2,00)	29,56 (0,88)	27,00 (4,66)	28,00 (2,88)
MBLF_Tongue	38,22 (0,44)	38,80 (0,63)	38,78 (0,44)	38,78 (0,67)	38,87 (0,35)	38,38 (1,77)	38,00 (0,58)	39,00 ()	38,11 (2,32)	38,56 (1,01)	38,25 (1,16)	37,75 (2,76)
MBLF_TOTAL (%)	98,99(0,54)	98,38 (2,20)	99,70 (0,45)	97,90 (3,71)	95,95 (4,67)	94,03 (5,34)	92,79 (7,36)	99,77 (0,64)	97,70 (4,42)	98,90 (1,33)	95,50 (5,64)	96,28 (4,85)

Figures

Figure 1. Criterion validity of the MBLF protocol against Sunnybrook Facial Grading System (SFGS)

Regression analysis of MBLF_TOTAL by SFGS_TOTAL (a), MBLF_Face by SFGS-Rest (b), MBLF-Eye by SFGS-Eye (c) ans MBLF-Lips by SFGS-Lips (d).

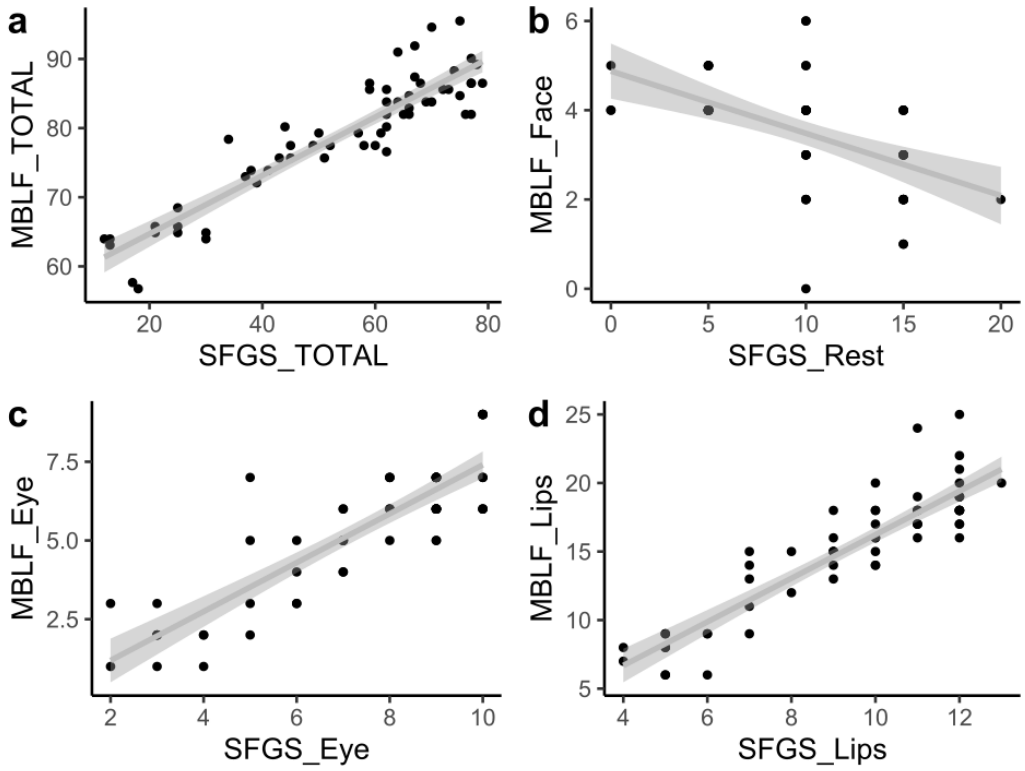


Figure 2. Effect of severity House and Brackmann grade on MBLF_TOTAL scores

Significant differences were found between severity grades of House and Brackmann (HB) on MBLF_TOTAL. MBLF scores were converted into percentages.

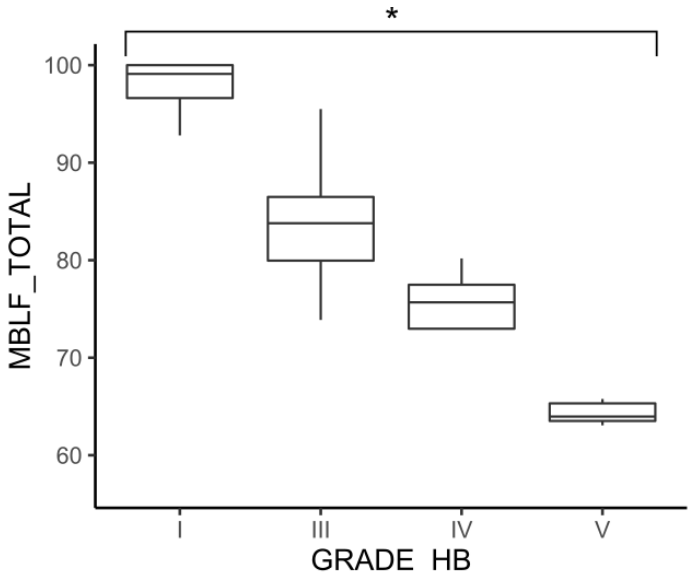


Figure 3. Effect of severity House and Brackmann grade on MBLF sub-scores

Significant differences were found between severity grades of House and Brackmann (HB) on MBLF_Face, MBLF_Eye, MBLF_Lips and MBLF_Cheeks. MBLF scores were converted into percentages.

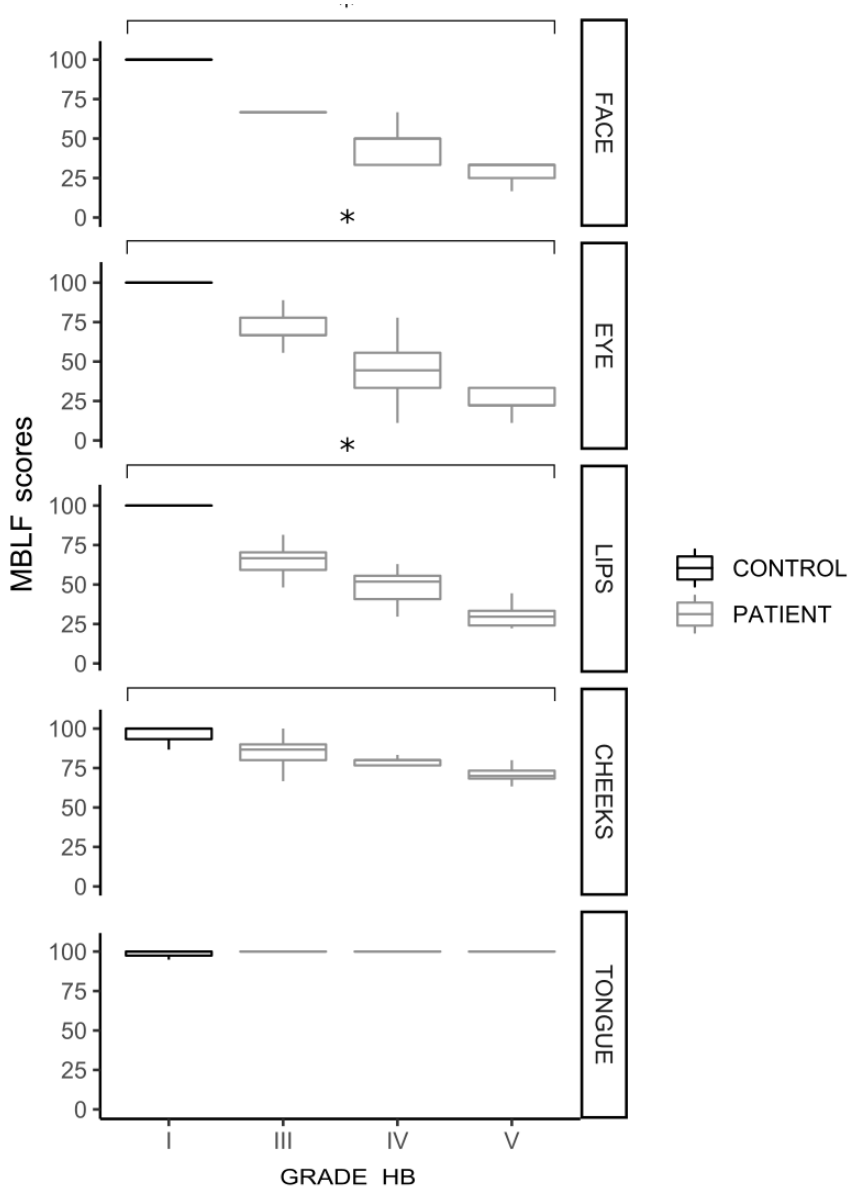
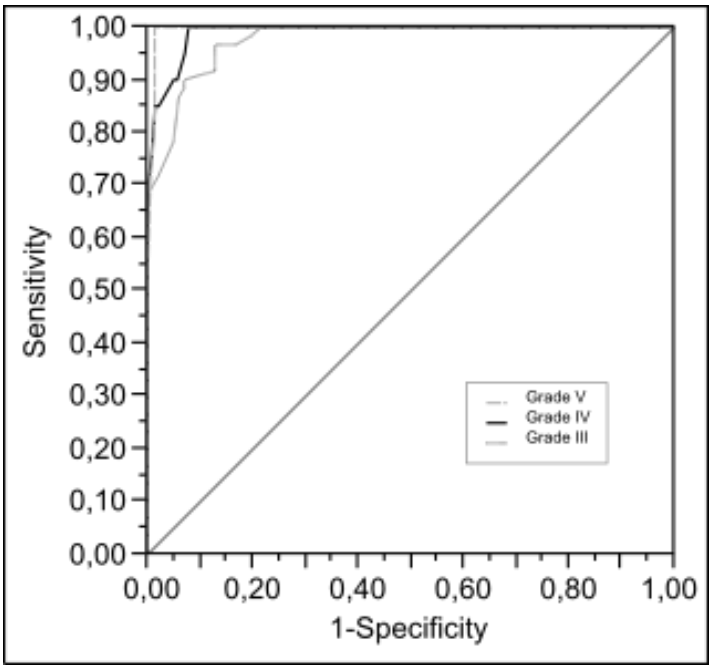


Figure 4. ROC curves of MBLF_TOTAL and House and Brackmann severity grades



Appendix - MBLF protocol

Facial areas	Oral Motor Tasks	Muscles	0	1	2	3	Score
Face	Symmetry at rest						
	Symmetry when smiling						
							/6
Eyes	Close your eyes	Orbicularis oculi					
	Raise your eyebrows	Occipito-frontalis					
	Frown	corrugator supercilii					
							/9
Lips	Pinch your lips	Compressor/buccinator					
	Stretch your lips	Zygomaticus/risorius					
	Keep your lips closed strongly	orbicularis oris/masseter					
	Open mouth smile	Zygomaticus/risorius					
	Show the upper teeth	Levator labii superioris					
	Show the lower teeth	Mentalis					
	Say « u »	Orbicularis oris					
	Whistle	Orbicularis oris					
	Blow	Orbicularis oris					
							/27
Cheeks and mandibles	Open your mouth	Buccinator/orbicularis oris					
	Close your mouth	Masseter/orbicularis oris					
	Puff off the cheeks	Buccinator/orbicularis oris					
	Puff left cheek	Buccinator/orbicularis oris					
	Puff right cheek	Buccinator/orbicularis oris					
	Pass the air from one cheek to another	Buccinator/orbicularis oris					
	Suck in the cheeks	Buccinator/orbicularis oris					
	Left jaw open mouth	Pterygoid					
	Right jaw open mouth	Pterygoid					
	Chew closed mouth						
							/30
Tongue	Stick the tongue out	Genioglossus /Transverse					
	Bring in the tongue	Hyoglossus / Superior longitudinal					
	Put the tongue to the right corner of the mouth	Pharyngoglossus					
	Put the tongue to the left corner of the mouth	Pharyngoglossus					
	Put it on top	Superior longitudinal					
	Put it down	Superior longitudinal					
	Put your tongue on your teeth	Styloglossus / Hyoglossus					
	Move the tongue inside the right cheek						
	Move the tongue inside the left cheek						
	Raise the tip in the mouth	Pharyngoglossus					
	Raise the tip out of the mouth	Styloglossus					
	Click of disagreement	Styloglossus					
	Rhythm of galloping horse	Styloglossus					
							/39

- Rating: 0 = no contraction; 1 = initiated movement ; 2 = almost complete movement; 3 = normal contraction
- Face symmetry: 0 = severe / complete asymmetry ; 1 = significant /moderate asymmetry ; 2 = mild asymmetry ; 3 = complete symmetry

Appendix – Computerized MBLF Protocol