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ORIGINAL ARTICLE

Role of Electroneurography as a Prognostic Indicator for Bell's Palsy Patients

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ABSTRACT

The aim of this study was to evaluate the role of electroneurography test in the prediction of outcome of patients with Bell's palsy (BP).

Methods: This Cohort study was carried out in the electrophysiological unit of Rheumatology and Rehabilitation department, at Zagazig University Hospitals on 30 adult patients with Bell's palsy. All 30 subjects were assessed clinically by sunnybrook facial nerve grading score (SBS) and electrophysiologicaly by electroneurography (ENoG) test first evaluation was done within 7th-10th day from onset, the second evaluation at 20 days and the follow up visit was at 30th to assess the clinical grading system (SBS).

Results: There was statistically highly significant increase in SBS with increase follow up time. There was statistically highly significant decrease in compound muscle action potential (CMAP) amplitude more than 50% difference from healthy side in both frontalis and mentalis when comparing 1st with 2nd evaluation. At one month, 20 patients (66.7%) had good recovery, while 10 patients (33.3%) had poor recovery according to the Sunnybrook scale. Multiple logistic regression analysis showed that the most significant predictive indicator of BP recovery was ENoG degeneration index. The receiver operating characteristics (ROC) curves showed ENoG degeneration index of 74.6% as a critical cutoff value of non-recovery, with the sensitivity 95% and specificity 90%.

Conclusion: This study showed that ENoG degeneration index has an important role as a significant prognostic indicator for predicting of recovery of Bell's palsy. Sunnybrook score can be used as an additional tool in predicting non-recovery in the clinical evaluation.

Keywords: Bell's palsy; electroneurography; Sunnybrook score**.**

1-INTRODUCTION

The facial nerve is a mixed cranial nerve originates from its nucleus in the lower pons, a motor part provides innervation of ipsilateral half of the facial expression muscles of the face; as well as the posterior belly of the digastric, the stapedius, and the stylohyoid muscles. The sensory and parasympathetic part of facial nerve are carried by fibers that constitute the nervus intermedius, sensory fibers carry taste sensation from anterior two-thirds of the tongue and parasympathetic fibers serves to control the flow of saliva and tears from salivary and lacrimal glands. Finally it emerges from the stylomastoid foramen before entering the parotid gland, where it bifurcates into upper and lower divisions and subsequently into 5 branches: temporal, zygomatic, buccal, mandibular, and cervical **[1]**

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Bell's palsy (BP) is acute idiopathic unilateral lower motor neurone facial nerve weakness or paralysis without any accompanying signs of neurologic or systemic manifestation **[2]**. It is a common idiopathic cranial mononeuropathy with annual incidence rate ranging between 13 - 53 cases per 100,000 of population **[3].** In Egypt BP giving incidence rate (98.9 – 107) /100000 of population, higher among male patients than female patients and peak age between 18 and 60 years, with low incidence at extremes of age **[4].**

The etiology of BP is still unknown and remains a diagnosis of exclusion. The etiological theories of Bell's palsy include; viral infection theory, autoimmune inflammatory disorders theory, vascular ischaemic theory and exposure to cold air draft **[5].**

The characteristic clinical findings are acute onset of unilateral lower motor neuron facial paralysis that affects muscles of the upper and lower face and its peak 72 hours, usually accompanied by pain of neck, mastoid or ear, hyperacusis or altered facial sensation. House-Brackmann (HB) scale **[6]** and Sunnybrook scale (SBS) **[7]** are the most widely used clinical grading systems for recording the severity and monitoring outcomes of BP **[8]**

The electrophysiological tests are one of supportive tools for localizing the lesion site along the nerve, determine the severity of the injury and differentiate whether an injured nerve is still degenerating or regenerating [**9]** Electroneurography (ENoG) is the most powerful tool for prognostication of non-recovery and the most frequently electrophysiological tests have been used to determine BP prognosis **[10]**.

Although electrical tests were already introduced in the 1970s [**11**] and many controversial studies concerning the prognostic value of each of these tests have followed **[12, 13, 14].** We discussed in our study, the usefulness of ENoG and correlate these findings on Sunnybrook scale after 1 month to evaluate the role of ENoG test in the prediction of outcome of patients with Bell's palsy patients.

2. Subjects and Methods

2.1. Study design and subjects:

This cohort study was conducted in the Electrophysiological unit of Rheumatology and Rehabilitation department, at Zagazig University Hospitals. Thirty Bell's palsy patients who visited Rheumatology outpatient clinic during period of six months between April 2018 and October 2018 were included in this study. Their ages ranged from 19-54 years.

Patients diagnosed as unilateral Bell's palsy at Rheumatology outpatient clinic within first 10 days from onset and have sufficient physical and mental ability to understand the instructions and to cooperate throughout the session were included in study.

Patients with a previous history of peripheral facial paralysis, Ramsay Hunt syndrome, traumatic facial paralysis and central or peripheral nervous system disease other than idiopathic facial paralysis, facial palsy due to upper motor neuron lesions or any known cause of the infection e.g otitis media, autoimmune disease e.g sarcoidosis, diabetes mellitus and presence of cardiac pacemaker were excluded.

Written informed consent was obtained from all participants and the study was approved by the research ethical committee of Faculty of Medicine, Zagazig University. The work has been carried out in accordance with The Code of Ethics of the World Medical Association (Declaration of Helsinki) for studies involving humans.

2.2. Clinical grading by Sunnybrook score

The Sunnybrook Scale (SBS) **[7]** range from 0 (complete paralysis) to 100 (normal facial function). The 3 sections to the SBS are 1- resting posture 2- voluntary movement 3- synkinesis. All are scored individually, then the scores are combined for a total or composite score. The SBS score is calculated as follows: SBS = SBS movement− SBS rest− SBS synkinesis. Higher total score relates to lower impairment while a lower total score relates to greater impairment. All the patients were evaluated by SBS at baseline (within 10 days), at 20 days and after 1 month of onset.

2.3. Electroneurography (ENoG) studies:

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The electroneurography studies were performed within 7th-10th day from the onset of the disease as a baseline evaluation on (NIHON KOHDEN) electrophysiological apparatus; it is ideal time to evaluate the nerve within the completion of Wallerian degeneration **[15]**. A second evaluation was done at 20 days.

ENoG responses were measured on the affected and unaffected sides via a bipolar surface stimulator placed over the stylomastoid foramen and recording from surface electrodes placed over the frontalis and mentalis muscles, increasing current intensity to evoke compound muscle action potential (CMAP). The CMAP was obtained from the frontalis and mentalis muscles to measure amplitude degeneration ratio as a percentage of the amplitude of the paralyzed side divided by the amplitude of the normal side **[16]** then from nasalis muscle to measure degeneration index (DI) using the equation : [100-(ENoG amplitude affected/ unaffected side)×100]. **[8]**

During ENoG test a 50% degeneration ratio in the amplitude of the CMAP of the affected side (in comparison with the unaffected side) in both frontalis and mentalis muscles was used as the criterion indicating axonal degeneration pathology **[17]** which more likely to develop an incomplete recovery, while in nasalis muscle, patients with 90% degeneration on the affected side were considered to have a positive test **[18]** and referred to neurotology for consideration of surgical decompression within 14 days of symptom onset **[19]**

2.4. Statistical methods.

All statistical analyses were performed using IBM SPSS Statistics, version 18. Data from neurophysiological assessments are presented as mean standard deviation or median (interquartile range [IQR]), as appropriate. Comparisons between different Sunnybrook score of BP severity at follow up were investigated by the Fr: Fridman test. Cutoff values of DI were investigated by means of receiver operating characteristic (ROC).Odds ratios (OR), their corresponding 95% confidence intervals (95% CIs) and P values were computed using logistic regression analysis to evaluate the effect of possible prognostic indicators on recovery. All potential predictors were added in the model as independent variables. The results are presented as odds ratios (ORs) with 95 % confidence intervals (CIs). *P*-value<0.05 indicates a statistically significant difference.

RESULTS

The demographic, clinical characteristics and Sunnybrook score (SBS) among the studied cases at different time of follow up of the 30 studied patients are summarized in (table 1). There was a highly statistically significant increase in SBS with increase follow up time (P < 0.001). Table 2 summarizes the electrophysiological data. The ENoG test showed difference in findings between the first and second assessments, with (P values <0.001). Amplitude degeneration ratio of the frontalis was > 50% with 21 cases (70%) during baseline evaluation and with 12 (40%) during 2nd evaluation (P = 0.01) while mentalis was > 50% with 27 cases (90%) during baseline evaluation and with 10 (33.3%) during 2nd evaluation (P <0.001), DI of nasalis was more than 90% with 4 (13.3%) during baseline evaluation and 3 (10%) cases during 2nd evaluation (P = 0.004).

At one month, 20 patients (66.7%) had good recovery, while 10 patients (33.3%) had poor recovery according to the Sunnybrook scale, (table 3) summarizes the baseline electroneurography data according to the clinical outcome at 1 month; 21 patients had frontalis amplitude ratio >50, 12 of them recovered (57.1%) and 9 non-recovered (42.9%), 27 patients had mentalis amplitude ratio >50, 17 of them recovered (62.9%) and 10 non-recovered (37.1%), no statistically significant association between recovery and degeneration ratio of frontalis and mentalis while degeneration index was significantly decreased in patients with good recovery compared with poor recovery patients (P = 0.002).

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According to the area under ROC curves (figure 1) predicting the recovery of DI at 1 month was 0.92 (CIs 0.83–1) at baseline. The best possible prediction values of DI were 75% (95% sensitivity, 90% specificity).

According to logistic regression analysis (table 5), only the combination of clinical grading with Sunnybrook score and degeneration index provided useful data in predicting those subjects who would not recover after facial paralysis (OR = 5.1, P= <0.001) (OR =3.5, P = 0.02) respectively.

Table 1 Demographic and clinical data of studied patients.

Variable	(*n*=30)				
Age : (year)					
Mean ± SD	33.9 ± 10.35				
Range	19 - 54				
Variable	**N**	**%**			
Sex:					
Male	9	30			
Female	21	70			
Side:					
Rt	12	40			
Lt	18	60			
Variable			Median (Range)	Fr	P
SBS:					
1st evaluation (7th -10thdays)			**20 (5 - 46)**	**58.07**	**<0.001**
2nd evaluation(20 days)			**44 (7 – 77)**		******
follow up (30 days)			**78 (11 - 96)**		

Fr: Fridman test **: Highly significant (P<0.01)

Table 2: Electroneurography data at 1st and 2nd evaluation.

Variable	Base line (7th -10th days) (n=30)		2nd evaluation (20 days) (n=30)		Mc	P
	N	**%**	**N**	**%**		
Frontalis degeneration ratio%:						
>50	21	70	12	40	**3.24**	**0.01**
≤50	9	30	18	60		*****
Mentalis degeneration ratio%:						**<0.001**
>50	27	90	10	33.3	**12.56**	******
≤50	3	10	20	66.7		
DI of nasalis:						
>90	4	13.3	3	10		
90-76	6	20	4	13.3	**17**	**0.004**
75- 50	11	36.7	3	10		******
<5*0*	9	30	20	66.7		

Mc: McNemmar test *: Significant (P<0.05) **: Highly significant (P<0.01)

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Table 3: Relationship between electrophysiological data and recovery at 1month according to Sunnybrook scale (SBS).

variable	Recovered SBS≥70 (n=20)		Not recovered SBS<70 (n=10)		P
	N	**%**	**N**	**%**	
Frontalis amplitude ratio:					
>50	12	75.1	9	42.9	0.20
≤50	8	88.9	1	11.1	NS
Mentalis amplitude ratio::					
>50	17	62.9	10	37.1	0.56
≤50	3	100	0	0	NS
DI of nasalis:					
>90	0	0	4	100	0.02
≤90	20	67.9	6	60	*

Fisher exact test *: Significant (P<0.05)

Table 4*: Validity of different parameters in prediction of patient improvement among the studied patients:*

Variable	Cut off	AUC	CI	P	Sensitivity	Specificity	PPV	NPV	Accuracy
SBS 1st	**>13.5**	0.92	0.83-1	<0.001**	85	90	94.4	75	86.7
Frontalis	**>795**	0.91	0.74-1	<0.001**	95	90	95	90	93.3
Mentalis	**>820**	0.95	0.86-1	<0.001**	90	80	90	80	86.7
DI	**74.67 %**	0.90	0.73-1	<0.001**	95	90	95	90	93.3

Table 5: Logistic regression analysis for significant predictors for Bell's palsy recovery:

Variable	B	S.E.	Wald	Sig.	OR	95.0% C.I.	
						Lower	**Upper**
SBS 1st>13.5	**1.41**	**0.65**	**4.01**	**<0.001****	**5.1**	**2.67**	**6.12**
Frontalis degeneration ratio <50	0.08	0.12	0.98	0.29	1.02	0.83	2.01
Mentalis degeneration ratio <50	-0.02	0.03	0.78	0.38	0.98	0.93	1.03
DI <90	**1.23**	**0.42**	**2.98**	**0.02***	**3.15**	**1.98**	**4.54**

DI = degeneration index; SBS = Sunnybrook score; OR = odds ratio.

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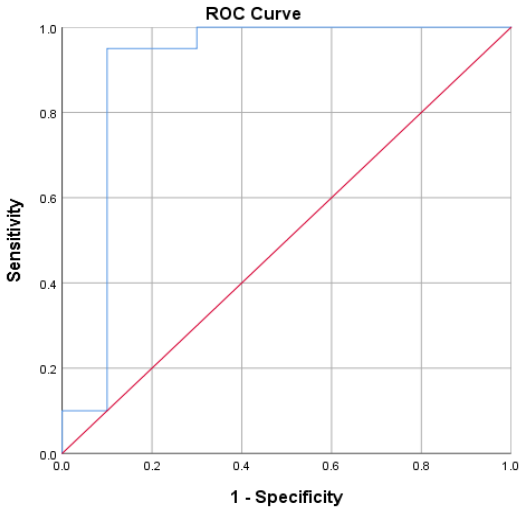

Figure (1): Roc curve for validity of DI in prediction of patient improvement after 1 month.

DISCUSSION

We aimed in our study to evaluate the usefulness of ENoG tests and correlate the findings on Sunnybrook facial nerve grading scale in the subjects with Bell's palsy to predict the outcome at one month.

Our study included of 30 BP patients, their ages ranged from 19 to 54 years, with a mean of 33.9 ± 10.35 years. Peitersen stated that the peak incidence occurs between the 2nd and 4th decades (15 to 45 years) but the disease may occur at any age **[20].**

In our study 21 patients were females (70%) and 9 patients were males (30%). Holland and Weiner [**21**] have reported that there was a slight female preponderance or they are equally affected while both males and females were affected equally according to Peitersen study [**20**]. In contrast, Byun et al. recruited 66 patients diagnosed as BP and found a male preponderance in his studied patients. The ratio of male to female was (2:1); however, they did not found a correlation between the patient's sex and recovery [**12**].

Eighteen patients (60%) presented with left side face affection while eleven patients had the right side being affected (40%) in our study. There results go in agreement with Cirpaciu et al. [**13**] who reported that left side affected more than right side. In contrast, Byun et al. [**12**] found a right side predilection. However, in all studies there was no association between side of facial palsy and complete recovery, which is in agreement with our study **[12, 13].**

There was statistically significant difference between the serial SBS grades across the successive visits indicating clinical improvement of the patients In our study, 20 patients (66.7%) had good prognosis were considered to have a good prognosis according to SBS achieving score ≥70 and 10 patients (33.3%) had bad prognosis (SBS<70) based on the SBS at the end of 1 month. This result was consistent to Prakash and Raymond, who found that one third of the total number of patients recovered completely within 1 month and about 70% within two months after the onset of Bell's palsy [**22**].

In comparison of the amplitude of the CMAP of the affected side with the unaffected side, we found 21 patients (70%) and 27 patients (90%) of frontalis and mentalis respectively recorded degeneration ratio >50 during 1st evaluation while 12 patients (40%) and 10 patients (33.3%) of frontalis and mentalis respectively during 2nd evaluation (table 2). The findings in the present study are consistent with those of Danielides et al., who reported that when the CMAP decreased to a

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value below 51% of normal values (more than 50% degeneration ratio) prognosis for recovery was considerably worse [**23**].

Our findings were consistent with those study of Khedr et al., who assessed degeneration rate in the frontalis and orbicularis muscles conducted on 59 patients with BP using cutoff value of 50% and considered for poor-recovery at 3rd month follow up and found that patients who had a facial nerve degeneration ratio < 50% (38 cases) had a higher percent of good recover while patients with facial nerve degeneration rate > 50% (21 cases) [**24**].

We found that, four patients had DI >90, all of them non- recovered (100%) and 26 patients had DI <90, 20 of them recovered (76.9%) and 6 non-recovered (23.1%).

Our results were in consistent with the observations of Mantsopoulos et al., who found that not all of subjects with DI <90% showed complete recovery [**25**]. As opposed to these findings Linder et al. and Sittel et al. where a high percentage of BP subjects have been reported to spontaneously improve within 1 year of onset [**26, 27**]. This differences can be explained by the difference of etiology and degree of palsy, ENoG cutoff value, initial timing for evaluation and prognostic follow-up time which may be shorter in our study in comparison with other studies.

According to ROC curve we found that DI of 75% at baseline was the best predictor for non recovery at baseline. The test had 95% sensitivity, 93.3% accuracy and 90% specificity predicting the outcome. Although DI showed lower specificity and sensitivity when compared to studies that focus on severe grades **[14, 29].**

According to logistic regression analysis, only the best predictive indicator of poor recovery was combination of clinical grading with Sunnybrook score and degeneration index provided useful data in predicting those subjects who would not recover after facial paralysis**.** Consistent with studies that analyzed prognostic factors in 92 patients **[14]** with BP reported that the ENoG result was the best predictor of residual palsy.

CONCLUSION

This study showed that ENoG degeneration index has an important role as a significant prognostic indicator for predicting of recovery of Bell's palsy. Sunnybrook score can be used as an additional tool in predicting non-recovery in the clinical evaluation.

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