Significance of Electroneurography and Acoustic Reflex Tests in Determining the Prognosis of Bell's Palsy

Bell Paralizisinin Prognozunun Belirlenmesinde Elektronörografi ve Akustik Refleks Testlerinin Önemi

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ABSTRACT Objective: The aim of this study was to compare the efficacy of electroneurography and acoustic reflex tests for determining the prognosis of Bell's paralysis at the beginning of disease. **Material and Methods:** Fifty-two patients who referred to our clinic with Bell's paralysis were evaluated prospectively with topographic and electrodiagnostic tests. Patients who had facial paralysis last for more than five days, recurrent, bilateral paralysis and paralysis caused by trauma, otitis media or neoplasia were excluded from the study. Audiogram, tympanogram and acoustic reflex tests were performed. Patients with hearing loss and tympanograms other than type A were also excluded. Initially negative acoustic reflex tests were repeated on day 30 and 60. Electroneurography was performed repeatedly and patients were grouped according to the degeneration rate as degeneration less than 50%, 50-90% and more than 90%. The course of the disease was monitored by House-Brackmann grading system. **Results:** Thirty six patients were House-Brackmann Grade 5, and 16 were Grade 6. Paralysis recovered completely in 42 patients and partially in 10 patients in sixth month. In electroneurography, 65.9% of 44 patients who had degeneration less than 90% recovered completely in the second month (p =0.004) while 12.5% of eight patients who had degeneration more than 90% had partial recovery (p= 0.007). All patients who had positive acoustic reflex test initially, recovered completely in second month (p= 0.003); and in 80% of patients who had negative reflex test, no recovery was seen in 6th month (p= 0.008). **Conclusion:** Electroneurography and acoustic reflex tests were important prognostic tests for determining prognosis of Bell's palsy and they were significantly correlated with prognosis. When electroneurography cannot be performed acoustic reflex test can be performed with accuracy in determination of early prognosis of Bell's palsy.

Key Words: Bell palsy; reflex, acoustic; prognosis; electrophysiology

ÖZET Amaç: Bu çalışmanın amacı, Bell paralizisinin prognozunun hastalığın erken döneminde belirlenmesinde elektronörografi ile akustik refleks testlerinin etkinliğini karşılaştırmaktır. **Gereç ve Yöntemler:** Bell paralizisi ile kliniğimize başvuran 52 hasta prospektif olarak topografik ve elektronörografik testler ile değerlendirildi. Beş günden daha fazla süren yüz felci olan hastalar bilateral, nüksetmiş olgular, travma, otitis media veya tümörler nedeniyle yüz felci geçiren olgular çalışmaya alınmadı. Odyogram, timpanogram ve akustik refleks testleri yapıldı. İşitme kaybı ve A tipi dışında timpanogramı olan hastalar çalışmadan çıkarıldı. Başlangıçtaki negatif akustik refleks testleri 30. ve 60. günde tekrar edildi. Elektronörografik testler tekrarlanarak uygulandı ve hastalar dejenerasyon oranlarına göre %50'den az, %50-90 arasında ve %90'dan fazla olanlar şeklinde gruplandı. Hastalığın gidişi House-Brackmann derecelendirme sistemi ile izlendi. **Bulgular:** House-Brackmann derecesi 36 hastada grade 5, on altısında ise grade 6 olarak bulundu. Kırk iki hasta tamamen iyileşirken, 10 hasta altıncı ayda parsiyel olarak iyileşti. Elektronörografik dejenerasyonu %90'dan daha az olan 44 hastanın %65.9'u ikinci ayda tamamen iyileşirken (p= 0.004), %90'dan fazla dejenerasyon bulunan 8 hastanın %12.5'i parsiyel olarak iyileşti (p= 0.007). Pozitif akustik refleksi olan hastaların tümü ikinci ayda iyileşirken (p= 0.003), refleks testi negatif olan %80 olguda altıncı ayda iyileşme görülmedi (p= 0.008). **Sonuç:** Elektronörografi ve akustik refleks testleri, Bell paralizisinin prognozunun erken dönem tayininde önemli testler olup, etkinlik açısından istatiksel olarak da birbirleriyle korelasyon gösterirler. Elektronörografinin mevcut olmadığı durumlarda akustik refleks testi prognoz tayininde güvenilir bir şekilde kullanılabilir.

Anahtar Kelimeler: Bell felç; refleks, akustik; prognoz; elektrofizyoloji

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Bell's palsy is an alarming condition for patients as there is a great probability of developing a permanent facial deformity causing significant functional, aesthetical and psychological discomfort.[1] Patients generally wonder whether their facial functions will completely recover or not after treatment. They are also worried about the time needed to regain their facial functions.[1] In facial paralysis, the clinician has to deal with psychological expectations of patients by explaining the probabilities of prognosis in addition to arranging the medical therapy. Despite considerable advances in technology, the mechanism by which facial palsy develops is unclear, and there is still controversy about the significance of tests for evaluation of facial paralysis. In neurophysiological evaluation of acute facial paralysis, electroneurography (ENoG) and acoustic reflex test are used frequenilty in an attempt to detect neural degeneration and to predict the recovery of facial function.[2-5]

During early 1970s, Esslen and Fisch were first to employ ENoG in facial paralysis and after that time several electrophysiological tests have been used for determining the prognosis of the disease.[1,4,6] Electroneurography is an objective electrophysiological test and consists of the registration and measurement of the compound muscle action potential (CAP) generated by the synchronous firing of many motor units.[7,8] The response on the paralyzed side is compared with the healthy side and a percentage is derived which is presumed to be proportional to the number of degenerated fibers.[9] Electroneurography has an advantage to determine the axons that do not undergo Wallerian degeneration. Moreover, it was shown that the value of ENoG decreased from the 3rd-7th day after the onset of palsy till the day Wallerian degeneration completed.[10]

The innervation of the stapes muscle is provided by *nervus stapedius* originating from the facial nerve. Facial paralysis affects approximately 67% of motor neurons of the stapes muscle.[11,12] The acoustic reflex test is an objective test being used in Bell's palsy for topognostic and prognostic purposes.[7,13] However, there are few studies dealing with the acoustic reflex test and its importance for determining early prognosis of facial paralysis.[14,15] It was reported that the negative of acoustic reflex test especially within the first 3 weeks of facial palsy showed poor prognosis.[15] In literature, although 500- and 1000- Hz contralateral stimulus was used and claimed to achieve significant results in prognostication of facial paralysis, there is still a controversy regarding which frequencies to be used for evaluating facial palsy.[7,11] In this study we aimed to compare the efficacy of ENoG and acoustic reflex test for determining the prognosis of Bell's palsy and attain their feasibilities using House-Brackmann (HB) grading system as a follow-up criterion.

MATERIAL AND METHODS

PATIENTS

In this study, we prospectively monitored a total of 52 patients [29 females (55.7%) and 23 males (44.3%)] who met the study inclusion criteria out of 118 patients with Bell's palsy who referred to our clinic between September 2005 and 2007. The study was approved by the Institutional Human Subject and Ethical Committee (Registration no: 0272/2035). Informed consents were obtained from patients and they were evaluated with repeated topographic and electrodiagnostic tests for at least 6 months. The ages of patients ranged from 5 to 83 (mean: 45.5 years).

The diagnosis of Bell's palsy was made after performing systemic and otorhinolaryngologic examinations, laboratory and radiologic tests and pure tone audiograms. The patients who referred to our clinic within five days after onset of facial paralysis with HB Grade 5 and 6 paralysis, who had no history of recurrent or bilateral paralysis, who did not have the etiologies like trauma, otitis media, central neurologic diseases and neoplasms, and who came to visits properly for at least six months were included in the study.

The patients received a routine audiologic evaluation on the day they appealed. Pure tone audiogram, tympanogram and acoustic reflex tests were performed repeatedly. ENoG was performed on the days 5, 10 and 15. The patients who had hearing loss and those had tympanograms other than type

A were also excluded from the study. The regular follow-ups were organized as weekly during the first two months and as monthly thereafter.

CLINICAL EVALUATION OF FACIAL NERVE

The patients were evaluated clinically according to the HB facial paralysis grading system[16] on the first day they came to our clinic, and the grade of paralysis was recorded in order to assess relative clinical improvement noted in the control visits. The evaluation of patients according to HB grading system was performed in 2nd month, and if the facial paralysis did not recover in first 2 months, then the last evaluation was performed in 6th month. Having HB Grade 1 at control visit was considered as a complete recovery whereas having HB Grade 2 or greater was considered as a partial recovery.

ELECTRONEUROGRAPHY

Electroneurography plays an important role in the early determination of the severity and the prognosis of Bell's palsy. This test shows variability with a decreasing tendency on each day within the first two weeks after onset of palsy. An Amplaid MK 12 apparatus was used to perform and analyze ENoG. The patients' skin was prepared with an alcohol swab and skin preparing paste (Omni Prep). Electroneurography was first performed on the healthy side and then on the paralyzed side. The facial nerve was stimulated electrically with bipolar surface electrodes placed on the stylomastoid foramen region where the main trunk can be stimulated. The other pole was in front of the tragus of the ear. Another bipolar surface electrode was used as a recording electrode and placed to the nasolabial fold. A supramaximal stimulation of 0.1-0.2 ms duration at a frequency less than 1 stimulus per second was applied. Electroneurography test was performed on days 5, 10 and 15 as this period has the highest risk for nerve degeneration, and the values were recorded.[16] The rate of degenerated fibres of facial nerve was calculated using the following formula:

(1 – (CAP amplitude of paralyzed side / CAP amplitude of healthy side)) x 100 = % degenerated fibres, where CAP stands for compound action potential.

The patients were grouped into three categories according to the degeneration rate in ENoG as; **Group A:** Degeneration rate less than 50%, **Group B:** Degeneration rate between 50-90% and **Group C:** Degeneration rate more than 90%.

ACOUSTIC REFLEX TEST

The acoustic reflex was tested frequently until it appeared by means of an AZ 26 impedance audiometer. It was first tested on the day the patient first applied to our clinic. Following the conventional tympanometry, acoustic reflex thresholds at 500, 1000 and 2000 Hz were obtained by presenting a stimulus to contralateral and ipsilateral ears at 10 dB above the reflex threshold, and the stimulation values at these frequencies were recorded as (+) or (-). In our study we did not prefer to use the values of reflex at 4000 Hz in order to eliminate the negative values due to presbyacusis and reversed reflex by ipsilateral stimulation at 250 Hz.[17] While evaluating the values of acoustic reflex test, contralateral stimulus result was used. The acoustic reflex test was repeated on the days 30 and 60 respectively, if the initial acoustic reflex results were negative and if the negativity of reflex test was continued. Patients with abnormal tympanometry or hearing impairment more than mild sensorineural hearing loss were excluded from the acoustic reflex measurement to rule out the confounding factors.

According to the acoustic reflex test, patients were grouped into 4 categories as; **Group 1:** Patients who had positive acoustic reflex test initially, **Group 2:** Patients who had positive reflex test on day 30, **Group 3:** Patients who had positive reflex test on day 60 and **Group 4:** Patients who had still negative reflex test on day 60.

MEDICAL TREATMENT

All patients were subjected to the same initial therapeutic regimen. Metilprednisolone was administered for 15 days with the initial dose of 3 mg/kg and attenuated every three days; Acyclovir was administered orally 20 mg/kg, four times a day in children under 40 kg and 400 mg, five times a day

in adults for five days. Vitamin B, proton pump inhibitors and topical tears were also administered.

STATISTICS

Data analysis was performed by SPSS Windows Version 11.5 (Chicago, IL). For descriptive statistis, categorical variables were expressed as patient number and percentage (%). For categorical comparisons, Chi-square or Fisher's exact probability tests were used. To express the most effective risk factor in yielding poor prognosis, Multiple Variant Logistic Regression analysis was used. Statistical results with probability values less than 0.05 were ($p<0.05$) considered as significant.

RESULTS

CLINICAL FINDINGS

In our study, we evaluated 52 patients with Bell's palsy prospectively. Twenty nine of them were females (55.7%) and 23 were males (44.3%). Of the patients, 32 (61.5%) had left side and 20 (38.5%) had right side facial paralysis. Their ages ranged from 5 to 83 years (mean: 45.5 years); eight of them were younger than 20 years, 13 were between 20 and 40, 12 were between 40 and 60, 19 were older than 60 years.

When we evaluated the patients clinically at the first day according to the HB grading system, 36 (69.2%) had Grade 5 and 16 (30.8%) had Grade 6 facial paralysis. At the last visit on the 6th month, 42 patients (80.8%) recovered completely while 10 patients (19.2%) recovered partially. In Table 1, average recovery time according to the initial clinical grades of patients was summarized. In patients who had HB Grade 5 facial palsy, 24 of 36 patients (66.7%) recovered completely in the 2nd month, 32 of 36 patients (88.9%) in the 6th month and four patients (11.1%) had no recovery. In patients who had HB Grade 6 facial paralysis, six of 16 patients (37.5%) recovered in the 2nd month, 10 of 16 patients (62.5%) recovered in the 6th month and 6 patients (37.5%) had no recovery at the last control.

ELECTRONEUROGRAPHY FINDINGS

There were 24 (46.1%), 20 (38.5%) and eight (15.4%) patients in Groups A, B and C, respectively. In Table 2, duration of recovery with respect to the degeneration rate in ENoG was summarized. In Group A, 79.2% (p=0.004), in Group B 50.0% (p=0.375) and in Group C 12.5% (p=0.007) of the patients had complete recovery in the 2nd month. That is, 65.9% of the patients with less than 90% degeneration, had complete recovery in the 2nd month and 90.9% of the patients had complete recovery on the 6th month (p=0.01). Eighty seven point five percent of patients who had more than 90% degeneration had no recovery on the 2nd month and 25.0% had no recovery on the 6th month (p=0.02).

ACOUSTIC REFLEX TEST FINDINGS

There were 10 (19.2%), 22 (42.4%), 10 (19.2%) and 10 (19.2%) patients in Groups 1, 2, 3 and 4, respectively. Table 3 summarizes the relationship

TABLE 1: Complete recovery time according to the initial grade of facial palsy.

	2nd Month		6th Month	
Initial House-Brackmann grades	Complete recovery (n=30)	Partial recovery (n=22)	Complete recovery (n=12)	Partial recovery (n=10)
Grade 5 (n=36)	24 (80.0%)	12 (54.5%)	8 (66.7%)	4 (40.0%)
Grade 6 (n=16)	6 (20.0%)	10 (45.5%)	4 (33.3%)	6 (60.0%)

TABLE 2: Complete recovery time according to the degree of degeneration presented at ENoG.

	2nd Month			6th Month		
Degree of degeneration in ENoG	Complete recovery (n=30)	Partial recovery (n=22)	P	Complete recovery (n=12)	Partial recovery (n=10)	P
<50%	19 (63.3%)	5 (22.7%)	**0.004**	4 (33.3%)	1 (10%)	0.323
50-90%	10 (33.3%)	10 (45.5%)	0.375	7 (58.3%)	3 (30%)	0.231
>90%	1 (3.3%)	7 (31.8%)	**0.007**	1 (8.3%)	6 (60%)	**0.020**

TABLE 3: Complete recovery time according to acoustic reflex test results.

Acoustic reflex test results	2nd Month Complete recovery (n=30)	2nd Month Partial recovery (n=22)	P	6th Month Complete recovery (n=12)	6th Month Partial recovery (n=10)	P
Group 1	10 (33.3%)	0 (0%)	**0.003**	0 (0%)	0 (0%)	---
Group 2	19 (63.3%)	3 (13.6%)	**<0.001**	3 (25%)	0 (0%)	0.221
Group 3	1 (3.3%)	9 (40.9%)	**<0.001**	7 (58.3%)	2 (20%)	0.099
Group 4	0 (0%)	10 45.5%)	**<0.001**	2 (16.7%)	8 (80%)	**0.008**

(Group 1: Acoustic reflex was positive initially; Group 2: Acoustic reflex was positive on 30th day; Group 3: Acoustic reflex was positive on 60th day; Group 4: Acoustic reflex was still negative on 60th day)

between acoustic reflex test results and recovery rates and times. In Group 1, all 10 patients (p=0.003), in Group 2, 19 of 22 patients (86.4%, p<0.001), in Group 3, one of 10 patients (10.0%, p<0.001) and in Group 4, none of the patients (p<0.001) had complete recovery in the 2nd month. In 6th month, at the last visit, all patients in Group 2, eight patients (80.0%) in Group 3, and two patients (20.0%) in Group 4 had complete recovery.

When the groups in Tables 2 and 3 were compared, we derived the results mentioned in Table 4. In Table 4, acoustic reflex test results were correlated with ENoG results. Thirty one of 32 patients (96.9%) in Group 1 and 2 who had positive reflex test initially or on the 30th day had less than 90% degeneration, while only one patient (3.1%) from these groups had more than 90% degeneration. Among 8 patients who had more than 90% degeneration, five (62.5%) in Group 4 had a negative acoustic reflex.

When all the other conditions were left stable, (all the patients were accepted to have same features), the rate of poor prognosis for groups that had negative reflex test on day 60 was 8.4 (2.5-28.6) times higher than for groups that had positive reflex test on days 1, 30 and 60 (p=0.001).

DISCUSSION

In acute peripheral facial paralysis, the status of facial functions and the rate of facial nerve degeneration have to be known accurately in order to determine the probable prognosis and plan the treatment in a short period of time. Since 1970s,

TABLE 4: Comparison of ENoG and Acoustic Reflex test results.

Degree of degeneration in ENoG	Acoustic reflex test results Group 1 (n=10)	Group 2 (n=22)	Group 3 (n=10)	Group 4 (n=10)
<50% (n=24)	6 (60%)	13 (59.1%)	4 (40%)	1 (10%)
50-90% (n=20)	4 (40%)	8 (36.4%)	4 (40%)	4 (40%)
>90% (n=8)	0 (0%)	1 (4.5%)	2 (20%)	5 (50%)

(Group 1: Acoustic reflex was positive initially; Group 2: Acoustic reflex was positive on 30th day; Group 3: Acoustic reflex was positive on 60th day; Group 4: Acoustic reflex was still negative on 60th day)

numerous studies have been performed about different electrophysiologic and topographic tests.[2,5,11]

Electroneurography is probably the most commonly used neurophysiological test in facial nerve paralysis. The percentage of the response on the paralyzed side is proportional to the number of degenerated nerve fibres. The prognostic accuracy of ENoG for determining the prognosis of Bell's palsy was studied extensively.[1,4,6,18] For the first time in literature, Esslen and Fisch proposed ENoG as a more accurate method for early determination.[1,11] Fisch suggested that all patients with idiopathic facial palsy who had less than 90% degeneration in ENoG would regain normal facial movements spontaneously two weeks after onset.[11] In the study of Danielides et al., ENoG was employed for prognostic evaluation at the 2nd and 4th months and HB grading system was used as criterion of recovery in 250 patients who had Bell's palsy.[8] The patients who had degeneration less

than 50% of normal values achieved complete functional recovery within at least two months (97%).[8] When the degeneration was more than 50% of normal values, prognosis was worse and the time of complete recovery was prolonged to 4th month. If the facial nerve degeneration was more than 90% in ENoG, nearly no recovery was noted after four months. This study displayed that ENoG had 97.6% prognostic accuracy for in determining the early prognosis in facial paralysis.[8] Other authors, as well, who had studies on ENoG in facial paralysis reported that if degeneration rate in ENoG was more than 90%, only 25% of the patients had complete recovery in two months.[2,5,6,11] Evaluation of the time course of facial paralysis by means of serial testing of ENoG may provide more information to predict different pathologic conditions of the disease.[2]

In our study, early prognosis of Bell's palsy was evaluated according to the degeneration rates in ENoG. If the facial nerve degeneration rate was less than 50%, 79.1% of patients and if the degeneration rate was more than 90%, 12.5% of patients had complete recovery in two months. After six months, 95.8% of patients who had less than 50% degeneration and 25% of patients who had more than 90% degeneration recovered completely. When compared to the literature, our findings suggest that a degeneration rate more than 90% in ENoG indicates bad prognosis in Bell's palsy.

Since the facial nerve and facial nucleus are important portions of the acoustic reflex arc, acoustic reflex has been used as a diagnostic and topognostic test for assessment of facial nerve function.[15,19] In Bell's palsy, there is a variability in the occurrence of the stapedial reflex, which reflects the different behavioural patterns.[3] In case of facial nerve paralysis without middle ear pathology or a moderate-to-severe hearing loss, the presence of acoustic reflex at normal hearing thresholds likely to indicate that the site of lesion is distal to the stapedial branch of the facial nerve.[3] If acoustic reflex is absent, the pathology is proximal to the stapedial branch, but more likely involves extensive peripheral nerve.[3] Acoustic reflex test is an objective and reproducible topographic test in differential diagnosis and it is relatively easy to perform it with minimal discomfort to the patient. Clinically the activity of the stapedial reflex is evaluated using impedance audiometry.[12] Reson and Sellars found that there were correlations among the stapedial reflex, duration of palsy and extent of recovery and presented that normal acoustic reflex indicated a good prognosis as some of previous investigations.[3,20] Studies by Nakamura et al. and Citron and Adour demonstrated that the acoustic reflex test was an objective test for evaluating early prognosis of facial palsy.[13,15] They found facial nerve degeneration based on nerve excitability tests, in cases where the reflex did not reappear within 21 days. In the cases where the reflex was present initially or recovered within 21 days, the complete recovery chance of the paresis was very high.[10] Suzuki et al. used the results of contralateral stimulation at 500, 1000, 2000 Hz in acoustic reflex test for evaluation facial palsy and accepted a positive result in one of these frequencies as positive reflex.[17] Ekstrand and Glitterstam attributed prognostic value to the reflex only if it was present during the first 10 days.[20] The results showed that acoustic reflex was absent or abnormal in the presence of in 68.2% of patients with Bell's palsy and normal middle ear function. In a recent study, Ralli et al. reported that positive acoustic reflex test in 30 days after the onset of paralysis was displaying good prognosis, whereas positive test results after 37 days displayed bad prognosis with a partial recovery after 12 months in 153 patients with Bell's palsy.[10]

The prognostic evaluation of acoustic reflex test in Bell's palsy was performed by eliminating the values of 250 and 4000 Hz frequencies in order to eliminate the disadvantages of prebiacusis and false negativity in the present study. All patients who had positive acoustic reflex test at the first visit and 86.4% of patients who had positive reflex test on day 30 had complete recovery in two months. However, in only 10% of the patients whose acoustic reflex test became positive on day 60 and none of the patients who had still negative test on day 60 recovered completely in two months. Thirtieth day was a critical time for us to

evaluate the prognosis in this study. Positive reflex test before that day showed 90.6% good prognosis and all patients recovered completely in six months, and positive reflex after that day showed poor prognosis and only 50% of the patients recovered in six months. These findings are similar to literature mentioned above.

A combination of the middle ear reflex and electrical tests may provide some advantages over acoustic reflex test or ENoG alone, which include measuring both distal and proximal conditions of facial nerve function, being able to evaluate the facial nerve palsy in the patients with a moderate to severe hearing loss, and determining whether facial palsy is complicated with trigeminal nerve disorders.[3] In the present study, the prognosis of Bell's palsy patients fist determined according to the degeneration rate in ENoG, and acoustic reflex test result of same patient was compared to ENoG in order to evaluate their superiorities. In 88.6% of patients who had a degeneration rate less than 90% in ENoG, acoustic reflex tests were positive in the first 60 days. However, in patients who had more than 90% degeneration in ENoG, acoustic reflex tests were positive in only 37.5% of the patients and negative in 62.5% of them in 60 days. The values that were accepted as poor prognosis in ENoG and acoustic reflex test were matched within same patient population.

CONCLUSION

Both ENoG and acoustic reflex tests are important tracking tests for determination of prognosis early in Bell's palsy. Acoustic reflex test is reliable, noninvasive, fast and inexpensive, and it can be performed in every clinic. Exact prognostic diagnosis and judgement can be reliably established by the findings of ENoG. The prognostic acoustic reflex values were related to the quantitative ENoG results, which seemed to improve the diagnostic capabilities of acoustic reflex. Acoustic reflex test and ENoG can be used together or replace each other confidently. In clinics where EnoG cannot be performed, acoustic reflex test can be performed in order to determine the prognosis of the patient with Bell's palsy early and in this way the physician can have the chance to handle the anxiety of the patient more easily.

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