Prognostic Value of the Ratio of the Sum of the Compound Muscle Action Potentials of Three Healthy, Affected Muscles in Patients with Bell's Palsy

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Abstract

Background and Aims: Bell's palsy is the most common cause of unilateral facial muscle weakness. We aim to find out if a single test of facial nerve conduction performed early in the course of the disease, along with the recording of compound muscle action potential (CMAP) of 3 muscles on the affected side compared to the unaffected side would give a reasonable prognosis at 6 months. Materials and methods: Fifty patients with first-time Bell's palsy were included in the study, and the degree of involvement was assessed based on the House-Brackmann (HB) Grading System at disease onset, 3 months and 6 months.

Results: A good outcome (HB grades I and II) was seen in 28 patients (56%), and a poor/moderate outcome (HB grades III to VI) was seen in 22 patients (44%). Of those who had a ratio of $\geq 25\%$ (26 patients), 19 (73%) had a good outcome, while of thos e with a ratio of $< 25\%$ (24 patients), 15 (63%) had a poor/moderate prognosis. Fisher's exact test showed significant correlation between a CMAP ratio of $\geq 25\%$ and a good outcome (p = 0.022). Age, gender, history of diabetes or treatment with steroids was not correlated with prognosis.

Conclusion: A one-time three-muscle CMAP ratio of $\geq 25\%$ was highly consistent with a good prognosis

Keywords: Complications, Corneal Transplantation Methods, Indication, Keratoplasty, Penetrating.

Introduction

Bell's palsy is an acute, idiopathic and unilateral lower motor neuron facial paralysis. It is the most common cranial nerve palsy, with an annual estimated incidence of 11 to 40 cases per 100,000 people, and with geographical variation but not gender variation. It can appear at any age, but it most frequently affects middle-aged patients. It was first described by Sir Charles Bell in 1893, and, since then, has been commonly referred to as Bell's palsy.[1]

Bell's palsy is defined as an abrupt onset of facial muscle paralysis in the absence of other cranial nerve involvement. There are different

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etiologies, including immunological, infectious (mainly by herpes simplex virus), inflammatory and vascular, but the most common is idiopathic.[2,3,4] Weakness involves upper and lower facial muscles, and is usually associated with symptoms of mastoid or ear pain, dysgeusia, hyperacusis, and, occasionally, altered facial sensation. There are no diagnostic tests for Bell's palsy, and physicians consider it a diagnosis of exclusion.[5,6] Treatment options include steroids, which are the mainstay of treatment if given early in the course of the disease (preferably within 72 hours). Controversially and less frequently, antiviral therapy may be used. Eye care, oral care and physiotherapy are also part of management. A patient's main concerns about the disease may include disfigurement, speech problems, altered taste and difficulty with chewing food, while a physician's concerns may also include corneal ulcerations and synkinesis.[7,8,9]

It has been demonstrated that the outcome of Bell's palsy is related to the degree of facial nerve degeneration, which may be determined by studying the evoked motor response in the second or third week of disease onset. Diminution in the amplitude of the compound muscle action potential (CMAP) in the affected side compared to the normal side estimates the extent of facial nerve degeneration.[10,11,12] Previous studies have used successive assessments of facial nerve conduction to predict prognosis.[13] Electrical stimulation used in a facial nerve conduction study (NCS) is not a pleasant experience, and patients are often reluctant to have such a test repeated. In this prospective study, we aimed to assess the prognosis of Bell's palsy at 6 months using a single NCS. This would be a more comfortable experience and less expensive to patients.

We selected 6 months for follow-up as it is a realistic goal, since patients will be counseled more appropriately for this time. Since the facial nerve has many branches and supplies more than one muscle, and since muscles are usually affected to different degrees, it would be more appropriate to study the nerve's collective effect on more than one muscle, comparing it to the healthy side. In this study, we assessed the prognostic value of the ratio of the sum of CMAPs of three commonly tested muscles on the affected side (frontalis, nasalis and orbicularis oris) compared to that of the unaffected side. To the best of our knowledge, this method of assessment has not been previously done.

Patients with Bell's palsy who are seen in our neurology outpatient clinic are diagnosed based on clinical findings, without pursuing an explanation for the cause of their isolated, acute, lower motor neuron facial palsy. If no contraindication exists, they are treated with corticosteroids if seen within the first week, and preferably within the first three days. Rarely, we use antiviral therapy. An eye patch, ophthalmic lubricant and artificial tears are also given. Patients are routinely sent for a facial nerve conduction study early in the second week of their illness. They are also given a course of physiotherapy at a rehabilitation department. Patients are followed up with clinical evaluations at the initial appointment, 6 weeks, 3 months and 6 months. Clinical evaluations include an assessment of facial muscle strength, disfigurement, aberrant innervations, the eye condition and patient concerns. We estimate the patient's progress according to the House-Brackmann (HB) Grading System.[14]

Materials and Methods

This was a prospective study carried out in the neurology clinic at Jordan University Hospital in Amman, Jordan. Patients with Bell's palsy who were clinically assessed by the author were included in the study. Hard copies of patients' facial nerve conduction study results and their 6-month follow-up clinical notes were used for this study. Patients were excluded if they had a diagnosis other than Bell's palsy (e.g. Ramsay Hunt syndrome), or had Bell's palsy without available clinical or neurophysiological data.

All NCSs were performed by the same operator, on the same machine (Dantec) and using the same protocol. The facial nerve was stimulated at the postauricular point with supramaximal stimulation (20% current above the maximal response current), with recordings from the frontalis, nasalis and orbicularis oris muscles on both sides. All results were interpreted by the author in the physiology laboratory before learning the clinical response of the patient. The CMAP amplitude for each of the three muscles was measured, summed up and compared to the sum on the contralateral, unaffected side. The ratio between the two sums (affected/healthy) was calculated to represent the residual function of the affected nerve. For example, a CMAP ratio of 10% would indicate 90% nerve degeneration, while a ratio of 25% would represent 75% degeneration.

Patient demographic data, clinical data, CMAPs for the three muscles on each side, their sums and ratios were tabulated, and statistical analyses were done using SSPS. Correlations as well as associations were analyzed using appropriate methods. The outcomes were grouped based on HB staging, with those in HB I or II considered to have a good outcome, and HB III through VI considered to have a moderate/poor outcome. A CMAP ratio of 25% or more was studied to assess whether it could separate patients with a good outcome from those with a moderate/poor outcome using Fisher's exact test. The study was approved by our Institutional Review Board.

Results

Fifty patients were included in this study; 27 were female (54%) and 23 were male (46%), with a mean age of 42.6 ± 17.9 years, (ranging 16 to 80 years) (Table 1). The left facial nerve and the right were affected in 27 (54%) and 23 (46%) patients, respectively. Forty-two patients (84%) received steroid treatment, 12 had a history of diabetes (24%) and only two received antiviral treatment (4%). Two-thirds of patients (66%) were evaluated and treated on the first day of disease onset, and the remaining patients were managed within 2 to 5 days of onset.

The average HB stage at onset was 3.46 ± 1.1 (range 1 to 6), and 56% of patients were in stage IV (Figure 1). The average HB stage at 6 months was 2.34 ± 1.3 (range 1 to 6) with 18% of patients in stage IV. The mean three-muscle CMAP ratio was 0.28 ± 0.2 (range 0.00 to 0.78) (Table 1).

A good outcome was seen in 28 patients (56%), and a poor/moderate outcome was seen in 22 patients (44%). Of those who had a CMAP ratio of $\geq 25\%$ (26 patients), 19 (73%) had a good outcome, while of those with a CMAP ratio of $< 25\%$ (24 patients), 15 (63%) had a poor/moderate prognosis. Fisher's exact test showed a significant correlation between a CMAP ratio of $\geq 25\%$ and a good outcome ($p = 0.022$) (Table 2). Gender, age category, steroid use and history of diabetes were not correlated with a good outcome (p-values of 0.093, 0.39,

0.16 and 0.52, respectively). The outcome was also not affected by the side of the face involved.

Discussion

Many studies have shown strong correlations between nerve conduction study findings and the long- and short-term outcomes of Bell's palsy. In a study of 37 patients with Bell's palsy who had unilateral complete palsy, May et al. (1983) found that when the response to a nerve conduction study was ≥ 30%, about 84% had complete recovery, whereas when the response was < 25%, 88% had incomplete recovery.[12] Prakash et al. (2003) studied 37 patients with complete facial palsy and found a clear correlation between the degree of neuronal degeneration and the possibility and chance of good recovery.[15] Yasukawa et al. (1995) studied 47 patients with Bell's palsy and found that 80% of them had < 90% degeneration of the affected facial nerve, all of whom recovered satisfactorily within 4 months.[16] In our study, we found there is a strong correlation between clinical outcome at 6 months and the severity of facial nerve damage measured by a NCS early in the second week after the onset.

The differences in clinical outcome at 6 months were not statistically significant between different genders, age groups, or presence of diabetes. However, several previous studies have shown that increased age is associated with poorer outcomes.[17-20] However, the study by Prakash (2003) showed a similar lack of correlation with age.[15] The fact that our sample size was small and that most of the patients were young (42.6 ± 17.9 years) may explain the different results of our study.

The lower recovery rate in our study (56%)

compared to previous studies may possibly be explained by our strict definition of a good outcome (HB grades I or II), which indicates complete or almost complete recovery, which seems satisfactory to patients and physicians. The small sample size or racial differences may have played a role as well.

Steroid treatment has been shown to positively affect recovery from Bell's palsy at 3 months in 83.0% vs. 63.0% (p <0.001) of patients by Frank M et al.[10] In our study, we did not intend to address the effect of steroids on outcome, as steroids use is our standard of care. Most patients (84%) received steroids, and those who did not were generally seen later than 3 days of onset.

The limitations of our study include the relatively small sample size and the fact that it was performed at one center. Its strengths include NCS testing only once per patient, and having a single interpreter, operator and machine for the NCSs. Our study is the first in our region to evaluate the ratio of the sum of the CMAPs of three muscles on each side of the face. while a study from Lebanon (1997) did not specify which muscles were used to calculate the CMAP ratios, and the 6-month prognosis showed full recovery of all patients with a CMAP ratio of ≥ 10%.[21]

Conclusion

A single facial nerve motor conduction study performed early in the second week of onset of Bell's palsy had a significant prognostic value at 6 months. A CMAP ratio of ≥ 25% was highly consistent with complete or almost complete recovery in Jordanian patients.

The author has no conflicts of interest to disclose.

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Table 1[a]

| Characteristic	Number (%)	Mean ± SD (range)
Total population	50 (100)	
Gender		
Female	27 (54)	
Male	23 (46)	
Age (years)		42.6 ± 17.9 (16.0 - 80.0)
Affected side		
Right	27 (54)	
Left	23 (46)	
Day of disease at initial evaluation		
Day 1	38 (76)	
Days 2 to 5	12 (24)	
History of DM	12 (24)	
Treatment with steroids	42 (84)	
Treatment with acyclovir	2 (4)	
Three-muscle CMAP ratio		0.28 ± 0.20 (0.00 - 0.76)
HB grade at onset		3.46 ± 1.1 (I - VI)
HB grade at 6 months		2.34 ± 1.3 (I - VI)

[a]DM: diabetes mellitus; CMAP: compound muscle action potential; HB: House-Brackmann Grading System (ordinal grade from I to VI, where I indicates normal function and VI indicates total paralysis).

Table 2: Correlation between different variables and a good outcome

Variable	Number	Two-sided p-value of the variable's correlation with a good outcome (by chi-square test)
Age		0.391
Young (≤ 50 years)	29	
Old (> 50 years)	21	
Gender		0.093
Male	23	
Female	27	
History of DM		0.52
Yes	13	
No	37	
Steroid use		0.116
Yes	42	
No	8	
CMAP ratio		0.022*
$\geq 25\%$	26	
$< 25\%$	24	

[a]DM: diabetes mellitus; CMAP ratio: sum of the amplitudes of the compound muscle action potentials (CMAPs) of the frontalis, nasalis and orbicularis oris muscles on the affected side/that of the healthy side. *statistically significant.

Figure 1: Distribution of the degree of facial muscle weakness at onset and at 6 months according to the House-Brackmann Staging System.
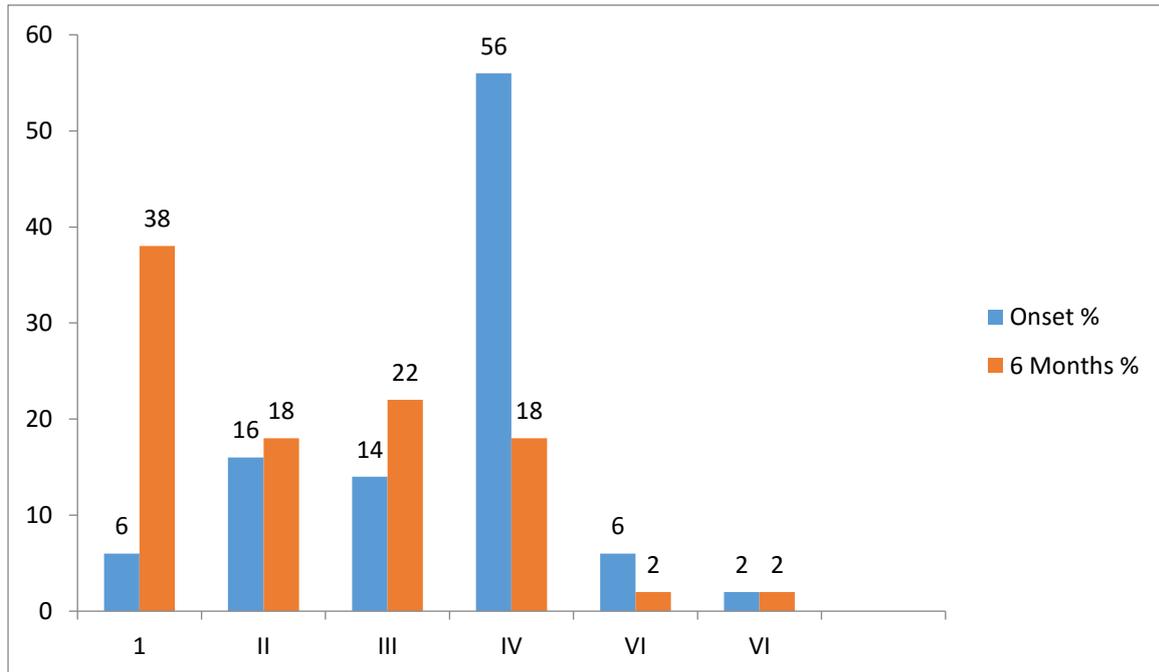
القيمة التنبؤية لتخطيط العصب السابع باستخدام مجموع استجابة ثلاث عضلات في الجهة المصابة مقارنة بالجهة السليمة عند مرضى شلل بل

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الملخص

الأساس العلمي: يشكل شلل بل أهم الأسباب لشلل الوجه الحاد. ويعدّ التنبؤ بالشفاء أو التحسن من هذا الداء بعد عدة شهور من الاصابة ذا قيمة سريرية هامة لكل من المريض والطبيب المعالج. طريقة الدراسة استباقية. تمّ دراسة خمسين مريضا عانوا من (شلل بل) بشكل حاد سريريا، في الأسبوع الأول من الإصابة قمنا بإجراء تخطيط كهربائي لعضلات الوجه في الجهتين (المصابة والسليمة) في بدايات الأسبوع الثاني وتمّ حساب نسبة مجموع استجابة ثلاث عضلات في الجهة المصابة مقارنة مع ثلاث عضلات مقابلة في الجهة السليمة، ودرست العلاقة بين هذه النسبة عندما تكون $\geq$ 25% مقارنة بالنسبة عندما تكون 25%> لدراسة فيما إذا كانت هذه النسبة جيدة للتنبؤ لحصول شفاء أو تحسن كبير بعد 6 شهور من تاريخ الإصابة اعتمادا على مقياس هاوس وبراخمان المكون من 6 درجات (الأولى تعني شفاء تاما والسادسة تعني عدم الشفاء).

النتيجة: تبين أنه عندما تكون النسبة لمجموع الاستجابة في الجهة المصابة 25%$\geq$ فإن احتمال الشفاء أو شبه الشفاء يكون عاليا جدا مقارنة بالنسبة التي تكون 25%>، وعليه فإن إجراء هذا الفحص لمرة واحدة لحساب هذه النسبة يعدّ ذا أهمية كبيرة في التنبؤ في مستقبل الإصابة بعد 6 شهور.

الكلمات الدالة: شلل بل، تخطيط عضلات الوجه الكهربائي، نسبة الإصابة في التنبؤ في التحسن.