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Sensitivity of auditory brainstem response in patients with acoustic neuroma

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Objective : *To find the sensitivity of auditory brainstem response in patients with acoustic neuroma*

Design : *Retrospective*

Setting : *Neurotologic Clinic, Department of Otolaryngology, Faculty of Medicine, Chulalongkorn University*

Subjects : *Forty-two cases of acoustic neuroma with their ages range between 17 and 70 years were recruited in 5 year study (1996 - 2000) at King Chulalongkorn Memorial Hospital*

Methods : *Medical charts of patients with acoustic neuroma who had both auditory brainstem response testing and computerized tomography or/and magnetic resonance imaging studies were reviewed. They are divided into four groups according to size of tumors: A, less than or equal to 1 cm; B, 1.1-2.0 cm; C, 2.1-3.0 cm; D, greater than 3.0 cm. The wave V interaural latency difference values and waveform morphology of auditory brainstem response were analyzed.*

Main outcome measure : *The sensitivity of auditory brainstem response in each group of the patients with acoustic neuroma were analyzed.*

Results : *The sensitivity of auditory brainstem response on wave V interaural latency difference at groups which tumor size of less than or equal to 1 cm, 1.1-2.0 cm, 2.1-3.0 cm and greater than 3 cm are 71.43 %, 88.89 %, 100 % and 100 % respectively. The sensitivity of auditory brainstem*

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response on waveform morphology at groups which tumor size less than or equal to 1 cm, 1.1-2.0 cm, 2.1-3.0 cm and greater than 3 cm are 71.43 %, 77.48 %, 100 % and 100 % respectively. And the over all of auditory brainstem response sensitivity in patients with acoustic neuroma were studied on wave V interaural latency difference and waveform morphology are 93.02 % and 90.70 % respectively.

Conclusion : *Auditory brainstem response in patients who have tumor size greater than 2 cm in diameter are absolute abnormality or absence at all (100 %). And the sensitivity is vary as size of tumors. It will be decreased if tumor size is smaller than 2 cm in diameter.*

Key words : *Auditory brainstem response, Acoustic neuroma, Sensitivity.*

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ปริญญา หลวงพิทักษ์ชุมพล, คเณศร์ แววงิจิต, ภาคภูมิ สุปิยพันธุ์, เพิ่มทรัพย์ อิสีประดิฐ. ความไวของวิธีทดสอบคลื่นไฟฟ้าการได้ยินระดับก้านสมองในผู้ป่วยที่มีเนื้องอกของเส้นประสาทหู. จุฬาลงกรณ์เวชสาร 2544 ก.ย.; 45(9): 767 - 75

วัตถุประสงค์ : *ศึกษาค่าความไวของวิธีทดสอบคลื่นไฟฟ้าการได้ยินระดับก้านสมองจากการได้ยิน (Auditory brainstem response: ABR)ในผู้ป่วยที่มีเนื้องอกของเส้นประสาทหูขนาดต่าง ๆ*

รูปแบบการวิจัย : *ศึกษาย้อนหลัง*

สถานที่ : *คลินิกโสตประสาทวิทยา ภาควิชาโสต นาสิก ลาริงซ์วิทยา คณะแพทยศาสตร์ จุฬาลงกรณ์มหาวิทยาลัย*

ผู้เข้าร่วมศึกษา : *ศึกษาข้อมูลจากรายงานประวัติในผู้ป่วยเก่าที่มีเนื้องอกของเส้นประสาทหู จำนวน 42 ราย อายุระหว่าง 17-70 ปี ซึ่งมีผลการตรวจทั้งแบบ ABR และ computerized tomography (CT) หรือ magnetic resonance imaging (MRI) ในรายเดียวกัน ใช้เวลาในการเก็บข้อมูล 5 ปี (พ.ศ. 2539 - พ.ศ. 2543)*

วิธีการ : *ศึกษารายงานประวัติผู้ป่วยที่มีเนื้องอกของเส้นประสาทหู ซึ่งได้รับการตรวจ ABR และมีผล MRI หรือ CT ยืนยันว่ามีเนื้องอกของเส้นประสาทหูจริง จัดแบ่งกลุ่มผู้ป่วยตามขนาดของเนื้องอกที่พบออกเป็น 4 กลุ่ม และนำผลวิธีทดสอบแบบ ABR ในแต่ละกลุ่มมาทำการวิเคราะห์*

การวัดผล : *วิเคราะห์ข้อมูลค่าความไวของวิธีทดสอบแบบ ABR ในผู้ป่วยที่มีเนื้องอกของเส้นประสาทหู*

ผลของการศึกษา : *ค่าความไวของวิธีทดสอบแบบ ABR โดยศึกษาจาก wave V ILD ในผู้ป่วยที่มีเนื้องอกของเส้นประสาทหูขนาดต่าง ๆ ตั้งแต่เล็กกว่าหรือเท่ากับ 1 ซ.ม., 1.1-2.0 ซ.ม., 2.1-3.0 ซ.ม. และใหญ่กว่า 3 ซ.ม. พบว่ามีค่าความไวเป็น 71.43 %, 88.89 %, 100 %, 100 % และศึกษาจาก waveform morphology มีค่าความไวเป็น 71.43 %, 77.78 %, 100 %, 100 % ตามลำดับ ค่าความไวของวิธีทดสอบแบบ ABR ในผู้ป่วยโดยรวมทั้งหมดที่ศึกษาจาก wave V ILD เป็น 93.02 % และศึกษาจาก waveform morphology เป็น 90.70 %*

วิจารณ์และสรุป : *จากการศึกษาครั้งนี้ พบว่า ผลที่ได้จากวิธีทดสอบแบบ ABR ในผู้ป่วยที่มีเนื้องอกของเส้นประสาทหูที่มีขนาดโตมากกว่า 2 ซ.ม. ขึ้นไปนั้น บ่งชี้ว่ามีความผิดปกติทุกรายและขนาดของเนื้องอกมีความสัมพันธ์กับค่าความไวในการตรวจพบด้วยวิธีทดสอบแบบ ABR โดยค่าความไวในการตรวจพบอยู่ในเกณฑ์ต่ำเมื่อเนื้องอกมีขนาดเล็กลง ฉะนั้นการทดสอบแบบ ABR จึงเป็นวิธีตรวจวินิจฉัยเบื้องต้นในผู้ป่วยที่สงสัยว่ามีเนื้องอกของประสาทหูทุกราย และจำเป็นต้องตรวจด้วยวิธี CT หรือ MRI เพิ่มเติมในรายที่ตรวจด้วย ABR แล้วไม่พบความผิด ปกติใด ๆ เพื่อป้องกันความผิดพลาด สำหรับการตรวจด้วยวิธี MRI นั้นมีค่าความไวในการตรวจพบความผิดปกติว่ามีเนื้องอกได้สูงถึง 100 % แต่มีค่าใช้จ่ายสูงมากกว่าวิธีตรวจด้วย ABR ประมาณ 30 - 40 เท่า*

Auditory brainstem response (ABR) testing was introduced in 1970 by Jewett et al.[1] It is a far field electrical potential that can be recorded from the scalp in response to acoustic stimuli. It has two basic clinical applications, they are an objective evaluation of hearing in patients who are unable to provide accurate response by behavioral testing and possible to use as a tool in neurological evaluation. Therefore it is also possible to use as a tool for diagnosis or localization of lesions in the brainstem.[2] In 1977, Selters and Brackmann showed that it has been advocated by many as a high sensitivity screening test for acoustic neuroma since the ABR has evolved to replace other site of lesion tests for retrocochlear pathology.[3] The ABR has been considered abnormal when the wave V interaural latency difference (ILD) was greater than 0.2 ms, the absolute wave V latency was abnormally prolonged, an interpeak latency (IPL) between wave I and wave V was greater than 4.4 ms, or there was abnormal or absent waveform morphology.

Several early investigators reported the sensitivity of ABR in detection cerebellopontine angle tumor as between 76 % and 98 %.[4-12] Recent studies have been shown ABR to be a reliable screening tool for tumors 2 cm or larger in diameter with sensitivity up to 100 %,[5-8] at the same time there were also reported of false negative response, especially with respect to small acoustic tumors.[4,9,13-16] This study was undertaken to evaluate the results of ABR testing in patients with acoustic neuroma interms of its accuracy and the usefulness as a screening diagnostic tool in retrocochlear pathology.

Methodology

Medical charts of patients with histologically confirmed with acoustic neuroma in King Chulalongkorn Memorial Hospital (KCMH) between 1996 and 2000 were retrospectively reviewed. ABR tracings; waveform derived at 90 dBnHL with TDH 49 earphones, and computerized tomography (CT) or/and magnetic resonance imaging (MRI) studies were analyzed. A subjective analysis of waveform morphology is made and the presence or/and absence of ABR wave I, III, and V is established. Absolute latencies of wave I, III, and V as well as interwave latencies for wave I-III, III-V, and I-V are measured. In addition, the latencies of wave V for two ears are compared and the values of ILD are calculated. The normal ABR results contain well defined waveforms with wave I through V clearly discernible. For each patient in this study, the following finding will be considered abnormal:

(1) nonreplicable waveforms (totally absent response),

(2) absent wave V with the presence of earlier waves,

(3) wave V absolute latency of greater than 6.1 ms with hearing loss less than 40 dBnHL at 3000 and 4000 Hz,

(4) I-III or III-V IPL exceeding 2.3 ms,

(5) I-V IPL exceeding 4.4 ms,

(6) wave V ILD exceeding 0.2 ms with symmetrical hearing

The ABR waveform morphology, absolute latency of wave I, III, V, IPL and wave V ILD were extracted from the database for analysis. The patients were then grouped according to tumor size as measured by the largest diameter in any plane on CT or MRI studies as: A, less than or equal to 1.0 cm; B, 1.1-2.0 cm; C, 2.1-3.0 cm; D, greater than 3.0 cm. The ABR sensitivity in each group were analyzed.

Results

Forty-two cases (43 ears) with acoustic neuroma were included in this study, 12 (28.57 %) were men and 30 (71.42 %) were women. Their ages ranged at the time of finding tumors from 17 to 70 years with a mean age of 43.76 ± 9.37 years. The tumors were on the right side in 22 cases (52.38 %), on the left side in 19 cases (45.23 %) and on bilateral in one case (2.3%). (Table 1)

The size of 43 tumors in this study ranged between 0.7-6.0 cm (average: 2.85±0.9 cm). Groups A, B, C and D are divided according to tumor size and demonstrated. (Table 2)

In group A, C and D, the sensitivities of ABR based on either wave V ILD or waveform morphology criteria are the same and at 71.43, 100 and 100 percent respectively. However, wave V ILD is more sensitive than waveform morphology in detective group B and overall tumors. There are 88.89 and 93.02 percent sensitivities using wave V ILD comparing to 77.78 and 90.70 percent sensitivities using waveform morphology criteria. Moreover, the sensitivity of ABR increases when tumors become larger. (Table 2)

Table 1. Demographic data of 42 cases with acoustic neuroma in this study.

Total	Sex		Age (years)				Side		
42 cases	Male	Female	17-30	31-45	46-60	60-70	R	L	Bilateral
N	12	30	9	16	13	4	22	19	1
%	28.57	71.42	21.42	38.09	30.95	9.52	52.38	45.23	2.38
$\bar{x}$	-	-	24.77	42.50	51.92	62.75	-	-	-

Table 2. Relationship of tumor size and ABR sensitivity using wave V ILD and waveform morphology criteria.

Group	N	Wave V ILD				Waveform morphology			
Tumor size (cm)		≤0.2	>0.2	Absent	Sensitivity	Normal	Abnormal	Absent	Sensitivity
A) ≤ 1.0	7(16.28%)	2	5	0	71.43	2	5	0	71.43
B) 1.1-2.0	9(20.93%)	1	3	5	88.89	2	2	5	77.78
C) 2.1-3.0	13(30.23%)	0	4	9	100	0	4	9	100
D) > 3.0	14(32.56%)	0	4	10	100	0	4	10	100
Overall	43(100%)	3	16	24	93.02	4	15	24	90.70

≤0.2 ms = normal wave V I1D , >0.2 ms = abnormal wave V ILD

Absent = unidentifiable waveform, no response, Normal = all waves identifiable

Abnormal = absence of certain waveform

Discussion

It is important to realize that auditory nerve tumor, even large ones do not always results in pure tone hearing deficits.[9,12] It is estimated that up to 5% of all acoustic neuroma patients have normal pure tone threshold so further investigation is needed for evaluation.[5,9,14,15,16] In the past, much in the field of treating acoustic neuroma changed. In the 1960s, many kinds of clinical audiological analysis testing became available to assist in diagnosis of acoustic tumor. The tests such as tone decay test, stapedius reflex decay test, performance intensity phonetically balance index (PIPB) and Bekesy testing sustained to be as the tool for diagnosis retrocochlear lesion. The sensitivity of those tests were inadequate because of varying to 70-85 % reliability. In 1970 Jewett et al introduced ABR to be as the tool for neurological evaluation and subsequently, Selters and Brackmann (1977) showed the effectiveness of ABR as a high sensitivity screening test for acoustic neuroma. It has been well accepted technique for evaluation of the integrity of the retrocochlear auditory system since the ABR testing is the most popular. The ABR instrument was established at Neurotology Clinic, KCMH in 1990 and used as a tool in audiological and neurological evaluations. Recently, the authors reported the normative data of this instrument in Thai volunteers with normal hearing. The absolute wave latencies (wave I, III and V) were at 1.53±0.18 ms, 3.71±0.20 ms, and 5.61±0.21 ms respectively. The IPLs (wave I-III, III-V and I-V) were at 2.18 ±0.22 ms, 1.88 ±0.23 ms, and 4.07±0.30 ms respectively and the wave V ILD was at 0.06±0.27 ms.[17]

Abnormal ABR was established as no response, wave V ILD of greater than 0.2 ms and abnormal waveforms. We use these criteria as a diagnostic significance in searching for retrocochlear pathology. In our series of 43 tumors, presenting herein, we found that the overall sensitivity of ABR was 93.02 % using the wave V ILD abnormality and 90.70 % using the abnormal waveform criteria.

The subject in this study was 42 known cases of acoustic neuroma. Their ABR results were studied. In this study, tumor size was ranged from 0.7-6.0 cm (mean = 2.85 ± 0.9 cm) and only one patient had acoustic tumor on both sides. They were female more than male (30:12), and the average age was 42.50 years. It was found that 40 in 43 ears (sensitivity = 93.02 %) showed abnormal wave V ILD of ABR testing. There were 3 patients with tumor size less than or equal to 2 cm showed wave V ILD less than or equal to 0.2 ms and their ABR results seemed to be normal. As a matter of fact false negative ABR results were occurred. However it was shown that enlargement of tumor size effect to ABR results especially the tumor size greater than 2 cm (the sensitivity = 100 %).

By consideration on the waveform morphology, we found that 39 in 43 ears (90.70 %) were abnormal or absent ABR waveform morphology. There were 4 ears of the patients (9.30 %) with tumor size less than or equal to 2 cm showed normal waveform morphology. The results were false negative as the same as the group of tumor size less than or equal to 2 cm which wave V ILD within normal limits. In the group of tumor size greater than 2 cm and over, the sensitivity of ABR was increased to 100 % and all of waveform morphologys were extreme abnormality. They varied according to enlargement of the tumor. Finally, it was considered that ABR sensitivity decreased when the size of tumor was smaller than

2 cm in diameter. The CT and MRI were requested to investigate retrocochlear lesions for more accuracy. For optimal operative result, acoustic tumor must be detected early and the small tumor will be early diminished also. It may provide the best potential for hearing preservation as well as a lower risk of facial palsy. [9,10,14,18-23]

In the conclusion, the reduction of ABR sensitivity will be affected due to the small size of tumors and the ABR testing is particular inadequate for tumors which less than 2 cm. in diameter. Actually, some of all patients with acoustic neuroma (3-12 %) could not be detected acoustic tumor if the size of tumor is smaller than 2 cm and comparison with this study is 6.98 %. (Table 2) The criteria of wave V ILD greater than 0.2 ms might be missed diagnosis 28.57 % of acoustic neuroma at the group of tumor size smaller or equal to 1 cm, 11.11 % of tumor size between 1.1-2.0 cm. This study is concluded the same as many authors' reports that ABR is not a good screening test for smaller acoustic tumors. We should realize the limitation of an ABR evaluation because the ABR can not completely exclude the diagnosis of acoustic tumors. Even if the ABR results are normal, we should have confirmed with MRI studies in suspicious cases because MRI can reveal tumors as small as 0.3 cm in diameter. [5,6,8] And now MRI is the "gold standard" for acoustic neuroma testing, although false positive have been reported. [5,14,24,25] Actually, the ABR evaluation is an initial screening test for retrocochlear problems. It is not only an objective test but also not invasive process for patients. On the contrary they are safe and more comfortable. Testing is easy to conduct and it can be complete this procedure within an hour. The cost effective of ABR evaluation is cheaper than MRI studies in 30-40 times at KCMH. For saving the budget, ABR testing is the first prior requirement for differential diagnosis acoustic neuroma or retrocochlear pathology.

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