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Evaluation of the acoustic (stapedius) reflex test in children and adolescents with peripheral facial nerve palsy

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A B S T R A C T

Introduction: The stapedius nerve is one of the branches of the facial nerve in the temporal bone. It supplies the stapedius muscle, which is responsible for the attenuation reflex that protects the inner ear from loud noises. The stapedius (acoustic) reflex (SR) test is useful in identifying the site of facial nerve injury. The return of the SR (acoustic) to normal after an injury is a good prognostic factor in the treatment of facial nerve palsy.

Objective: The aim of this study was to evaluate the effect of FNP on the SR (acoustic) response and determine the acoustic reflex threshold (ART) levels on the affected side.

Material and method: In this study, 70 patients, 3–7 years old, were screened. The study population consisted of 26 boys (37%) and 44 girls (63%). Follow-up tests were performed 3–18 months after the initial tests.

Results: Most patients in the study population had a negative SR (acoustic) response on the affected side. In other patients, mean ART values were statistically higher on the affected side. There was no statistically significant relationship between a reflex response and the time from the onset of facial nerve palsy.

Discussion: In the available literature, the SR (acoustic) testing is limited in determining whether or not the reflex is present without stimulus frequency or ART measurements. It is estimated that the reflex response is negative with ipsilateral stimulation on the affected side in 35–80% patients.

Conclusions: The SR (acoustic) is absent in most patients on the affected side. The ART value was statistically higher on the affected side. The SR (acoustic) response was statistically time independent.

1. Introduction

Unlike the term "*paralysis*" of the facial nerve, which applies to the total loss of function of the mimic facial muscles, the terms "*palsy*" and "*paresis*" are used interchangeably as synonyms in literature [1,2]. The condition known as "*Bell's palsy*" was named for a Scottish physician, Sir Charles Bell, who discovered in 1821 that facial nerves supply innervation to the facial muscles. Our current knowledge about the pathogenesis of facial nerve palsy (FNP) is still incomplete and highly controversial [1,3]. Only 25% of all of FNP cases are caused by known, confirmed conditions. Among these cases, the most common causes are injuries (including iatrogenic), malignancies and inflammatory conditions [4,5]. The stapedius nerve is one of the branches of the facial nerve in the temporal bone. It supplies the stapedius muscle that arises from the pyramidal eminence in the posterior wall of the tympanic cavity. The stapedius and tensor tympani muscles are responsible for the attenuation reflex that protects the inner ear from damage due to high-intensity sounds [6]. The contraction of these two muscles causes stiffening of the chain of auditory ossicles and reduces sound intensities reaching the inner ear by 10 dB. However, this protection effect is limited by the latency period of 10 ms. The attenuation reflex always occurs bilaterally even if the stimulation is unilateral [7]. Measurement of the stapedius reflex (SR) (acoustic) is an objective testing method that is currently widely used to determine, for example, the location of facial nerve lesions. The reflex is absent both ipsilaterally and contralaterally if a lesion is proximal to the branching of the stapedius nerve from the main trunk of the facial nerve. This test is performed as a part of an

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impedance audiometry test. A single intermittent pure tone with increasing intensity is usually used as a reflex-activating stimulus. Acoustic reflex thresholds (ARTs) are determined separately for each frequency stimulus (500, 1000, 2000 and 4000 Hz) [7,8]. The ART is the most clinically important parameter measured during these tests. In addition, the ART is the lowest intensity level of the specific audio signal at which the stapedius contraction is measurable. The average physiological threshold value for the ART is 85 dBHL [7,9]. Return of the SR (acoustic) to normal after injury is a good prognostic factor in the treatment of FNP [7]. Another example of how the SR test is used in neurology is the early diagnosis of a cerebellopontine angle (CPA) tumour. The lack of SR response on the affected side with contralateral stimulation may indicate injury to the afferent part of the reflex arc even before any clinical FNP symptoms occur.

The SR response is absent in more advanced tumours, both with ipsilateral and contralateral stimulation [7,10,11].

2. Study objectives and hypotheses

2.1. Study objectives

The aim of this study was to investigate the effect of FNP on the SR (acoustic) to determine the ART levels on the affected side with symptoms of FNP. In addition, this study was performed to find the relationship between present SR and the time from the onset of FNP to impedance audiometry tests.

2.2. Hypotheses

1. The baseline SR will be absent on the affected side in most patients.
2. The mean ART value in those patient with a present SR, is higher on the affected side compared to the unaffected side."
3. There is no statistically significant relationship between present SR and the time from the onset of FNP to impedance audiometry tests.
4. The follow-up SR (acoustic) test that was performed $\geq$3 months after the onset of symptoms will be present on the affected side in almost all of the patients.

3. Materials and methods

3.1. Materials

The study enrolled patients treated for peripheral palsy of the facial nerve at the Department of Neurology, Provincial Specialist Children's Hospital in Olsztyn. The study was approved by the Ethics Committee at the Faculty of Medical Sciences of the University of Warmia and Mazury based on decision 35/2013, November 14, 2013. Written consent for the study was obtained from each patient who was at least 16 years old and from the legal guardians of the patients who were younger than 16 years. In this study, 70 patients, 3–17 years old, were screened between January 2012 and November 2013. The median age was 11 years old. The study population consisted of 26 boys (37%) and 44 girls (63%). Follow-up tests were performed 3–18 months after the initial tests on all of the patients who could undergo the procedure at the otolaryngology outpatient clinic. Forty-one children returned to the clinic for follow-up tests.

3.2. Inclusion/exclusion criteria

Eligible subjects had to meet all of the inclusion criteria and none of the exclusion criteria to undergo the first test comparing audiological parameters between the affected and unaffected sides. The SR response on the unaffected side was used as a control.

The inclusion criteria for the study were unilateral peripheral FNP, 3–17 years old and normal hearing on the unaffected side without symptoms of FNP.

The exclusion criteria comprised central FNP, bilateral FNP, hypoacusis (hearing loss) on the unaffected side, tumours or other lesions of the salivary gland that could be a potential cause of the nerve palsy and >30 days from the onset of symptoms to the SR test.

3.3. Methods

3.3.1. Audiological investigational tools

A baseline (initial) Impedance Audiometry (IA) test with an SR (acoustic) assessment was performed in the Audiometrics Laboratory of the Speech and Audiology Centre at the Provincial Specialist Children's Hospital in Olsztyn. The test was performed using an Interacoustic AZ 26 clinical impedance meter. The baseline IA test involved bilateral tympanometry with a tympanometric gradient measurement, static admittance (compliance) and middle ear pressure measurements, as well as an ipsilateral SR (acoustic) test with the ART measurement. The follow-up (second) IA test was performed in the Audiometrics Laboratory at the Specialist Diagnosis and Rehabilitation Centre for Paediatric Patients with Hearing Impairment of the Polish Association of the Deaf in Olsztyn. This test was also performed using an Interacoustic AZ 26 clinical impedance meter and involved the same measurements as the baseline tests. The IA tests were performed in all of the patients during baseline assessment ($N = 70$) and all of the patients who returned to the clinic for follow up ($N = 41$).

3.3.2. Statistical methods

Statistical analyses were performed using STATISTICA, version 9.1, and Microsoft Excel 2007 for Windows. The Student's *t*-test was used to determine differences between the two group means (unaffected side vs. affected side). Previously, the assumptions of normal distribution of the analysed variables and equality of variance were verified using the distribution analysis and F-test, respectively. The *p*-value was the probability that the hypothesis about the difference between the means was false. The assumed critical *p*-value (alpha) was set as 0.05. This means that a *p*-value >0.05 is not sufficient to reject the null hypothesis (H_0) stating that there is no difference between the means, and a *p*-value <0.05 is sufficient to reject the H_0 and accept the alternative hypothesis that there is a difference between the means. The relationship between positive SR (acoustic) response and the time from the onset of FNP to IA tests was determined using a chi-square test.

4. Test results

4.1. Baseline test results

4.1.1. Physical examination

In this study, 34 children (15 boys and 19 girls) were diagnosed with left FNP. In addition, 36 children (11 boys and 25 girls) were diagnosed with right FNP, and 23 patients out of 70 examined children reported hypersensitivity to sound on the affected side with FNP symptoms. The degree of facial paralysis was determined using the House-Brackmann Facial Nerve Grading Scale (HBFNGS). Among the patients with FNP, 11 subjects presented with Grade II HB, 39 subjects presented with Grade III HB, 16 subjects presented with Grade IV HB and 4 subjects presented with Grade V HB scores. No subjects were diagnosed with Grade VI HB facial nerve dysfunction (motor component). The corneal reflex test was