International Journal of Pediatric Otorhinolaryngology 75 (2011) 704–707

Contents lists available at ScienceDirect

International Journal of Pediatric Otorhinolaryngology

journal homepage: www.elsevier.com/locate/ijporl

Auditory brain stem response and otoacoustic emission results in children with end-stage renal disease

Masoud Naderpour [a], Fakhrossadat Mortazavi [b,*], Yalda Jabbari-Moghaddam [a], Mohammad H. Sharifi-Movaghar [a]

[a] Department of Otolaryngology – Head and Neck Surgery, Pediatric Health Research Center, Tabriz University of Medical Sciences, Iran
[b] Department of Pediatric Nephrology, Pediatric Health Research Center, Tabriz University of Medical Sciences, Iran

ARTICLE INFO

Article history:
Received 24 August 2010
Received in revised form 19 December 2010
Accepted 21 February 2011
Available online 21 March 2011

Keywords:
End stage renal disease
Pediatrics
Hemodialysis
Auditory brain stem response
Otoacoustic emission

ABSTRACT

Background: Abnormalities in auditory system are frequent in patients with end stage renal disease (ESRD). There is not yet any consensus for the effect of renal failure and hemodialysis on auditory complications. The aim of this study was to evaluate the auditory abnormalities in pediatric ESRD patients undergoing long term hemodialysis and compare the results with those of nondialytic chronic renal failure (CRF) children and controls.

Methods: Children aged 1–16 years were evaluated in three groups: 25 ESRD patients undergoing hemodialysis, 25 nondialytic patients with CRF, and 25 age and sex-matched normal counterparts. Patients with history of otological diseases, ear trauma, diabetes mellitus, receiving ototoxic drugs and syndromes with hearing abnormalities were excluded. The auditory brainstem response (ABR) and otoacoustic emission (OAE) were tested in all subjects. Frequency of cases with abnormal findings was compared between the groups.

Results: The ABR testing was abnormal in 11 (44%) dialytic patients with normal results in all nondialytic CRF cases and controls ($p < 0.001$). The OAE testing was abnormal in all dialytic patients with abnormal ABR testing results (44%), in 1 (4%) nondialytic CRF patient and in no controls ($p < 0.001$). There ware no significant differences with regard to age, gender, height, weight, blood pressure, serum levels of blood urea nitrogen (BUN), creatinine, sodium, and potassium, glomerular filtration rate (GFR), duration of dialysis and dialysis adequacy between dialytic patients with and without abnormal results of ABR/OAE testing.

Conclusion: Sensorineural hearing loss is rare among nondialytic pediatric patients with CRF but very common in ESRD children undergoing long term dialysis.

1. Introduction

Chronic renal failure (CRF) and end stage renal disease (ESRD) can cause malfunction of multiple organs, including auditory and vestibular systems [1]. Although the etiology of this malfunction is not definitely described, multiple factors have been proposed. Electrolyte disturbances, elevated serum urea level, episodes of hypotension, hypoxia, altered pharmacodynamics of ototoxic drugs, dysfunction or loss of hair cells, collapse of the endolymphatic space, edema and atrophy of specialized auditory cells, neuropathy, and in some patients, dialysis and its associated complications such as wide fluctuation in blood pressure during hemodialysis (HD) and accumulation of contaminants from dialysate water are some assumed ethiopathologies [2–6]. Selecting an appropriate testing method of the hearing organ is a pivotal step. The auditory brainstem response (ABR) reflects neural function along the ascending auditory pathway, from the cochlea to the inferior colliculus [7]. The otoacoustic emission (OAE) is a low level sound emitted by the cochlea in the process of receiving the sound vibrations and transforming them to cellular and neural stimulation. Recording of OAEs implies a functioning cochlea and healthy middle ear mechanism [8]. By now, there have been various number of studies focused on association between CRF and dialysis with abnormalities in hearing system in adult patients. Baldini et al. demonstrated elongation of wave III and V in ABR tests of CRF patients. They assumed a central and peripheral damage of hearing organ due to uremia [9]. Pagani et al. confirmed disorders of latency of wave III and V and IPL I–III and I–V in ABR testing of patients treated with chronic HD [10]. Based on different studies, frequency of hearing loss ranges between 20% and 77% in

* Corresponding author at: Tabriz University of Medical Sciences, Children's Hospital of Tabriz, Sheshgelan Street, Tabriz, Iran. Tel.: +98 411 5262280/914 1166729; fax: +98 411 5262279.
E-mail address: Mortazavi_fakhri@yahoo.co.uk (F. Mortazavi).

0165-5876/$ – see front matter © 2011 Elsevier Ireland Ltd. All rights reserved.
doi:10.1016/j.ijporl.2011.02.020

adult CRF patients and between 15% and 79% in dialytic ones [11–15]. There is only limited number of studies evaluating hearing abnormalities in children with CRF or ESRD. Bergstrom and Thompson [16] reported that 47% of 151 children with ESRD had hearing loss. Mancini et al. [17] investigated the incidence of sensorineural hearing loss in 68 patients who reached CRF in childhood and found that 29% of patients on conservative treatment and 28% of patients on HD had sensorineural hearing loss. There is a concern about possible differences between the pediatric and adult populations in this regard. Moreover, auditory complications in children with CRF or ESRD are more important than those in adults, because the deficits present during the childhood may deeply influence the growth, development and future life [18]. The aim of this study is to evaluate the auditory abnormalities in pediatric ESRD patients undergoing long term HD and to compare the results with those of nondialytic CRF children and control group.

2. Methods

In this cross-sectional study, children aged 1–16 years were recruited in three groups; dialytic group including 25 children with non-syndromic ESRD (GFR $<$ 15 ml/min/1.73 m^2 body surface area) under maintenance HD for 4 h, 2–3 times a week, nondialytic group including children with non-syndromic CRF ($15 \leq$ GFR $<$ 30 ml/min/1.73 m^2 body surface area) on conservative management, and controls including 25 normal healthy children. The three groups were matched for age and sex. GFR was calculated by applying Shwartz formula using height (cm) and serum creatinine (mg/dl) [19]. This study was conducted during an 18-month period between November 2008 and May 2010 in Children's Hospital of Tabriz in northwest of Iran. All subjects were thoroughly examined by an ear, nose and throat (ENT) specialist. Patients with history of otological diseases, ear trauma, diabetes mellitus, receiving ototoxic drugs, syndromes with hearing abnormalities (Alport syndrome, for example) and mental retardation were excluded. Only subjects with normal middle ear function as confirmed by tympanometric measurement were enrolled. The audiological tests including ABR and OAE were performed bilaterally by an expert audiologist blind to the group of subjects in an outpatient ward. The audiological tests carried out between HD sessions at least 24 h after dialysis. For measuring the hearing threshold we used ABR. Standards of employed ABR were 90 dB nHL, 30 impulses, click 125 ms half-wave square in frequencies between 1000 and 4000 Hz. The criteria for abnormal ABR defined as any rise in the hearing thresholds (cut-off value). The OAEs were measured using MADSEN Capella Oto Acoustic Analyzer, T1LA. Cases with no response in OAE were reported as abnormal (cut-off value). Other studied variables were age, gender, height and weight and their percentiles according to growth charts provided by the Ministry of Health and Medical Education, systolic and diastolic blood pressures, duration of CRF, duration of dialysis and dialysis adequacy, glomerular filtration rate (GFR), serum levels of blood urea nitrogen (BUN), creatinine, sodium (Na) and potassium (K). Kt/V ratio (K is the dialyzer clearance of urea, t is the dialysis time, and V is the patient's total body water) as an indicator of dialysis adequacy was calculated from pre and post dialysis blood urea, weight and ultra filtration volume [20]. All ESRD patients were dialysed by polysulphan dialyzers. Informed consents were signed by the parents of recruited children. This study was approved by the Ethics Committee of Tabriz University of Medical Sciences. Statistical analysis was performed using the SPSS software (Chicago, IL), version 15.0. Data are presented as mean ± standard deviation (median) or frequency (percent). Independent samples T-test, Mann–Whitney U-test, Chi-square test or Fishers' Exact test were used for comparisons. P-value of <0.05 was considered significant.

3. Results

Patients' characteristics, general data and on-admission laboratory results are summarized in Table 1. The mean duration of CRF was 3.21 ± 4.12 years (range: 1–6 years) in nondialytic group and 4.05 ± 5.32 years (range: 2–7 years) in dialytic group ($p = 0.12$). The mean duration of dialysis was 22.28 ± 12.19 months (range: 4–48, median: 18 months). The mean Kt/V was 1.26 ± 0.08 (range: 1.10–1.40, median: 1.20). In dialytic patients, ABR testing showed that 11(44%) patients had bilateral symmetric increased V latency (by 35 db amplitude in frequencies between 1000 and 4000) which indicated mild increased hearing thresholds in these cases. We found normal ABR in other two groups ($p < 0.001$). The OAE testing was abnormal in the same 11 patients in dialytic group (who had abnormal ABR), in 1 (4%) patient in nondialytic group and in no one in the control group ($p < 0.001$). There was not any child with normal tests in one ear and abnormal tests in the opposite ear. Different variables are compared between the dialytic patients with and without abnormal ABR/OAE testing results in Table 2. Accordingly, no significant difference was found between these two groups.

4. Discussion

In current study we found that abnormal ABR and OAE testing results were significantly more frequent in dialytic patients (44%) than the other two groups. Nikolopoulos et al. [12] studied hearing acuity in 46 children and adolescents suffering from renal insufficiency. Sensorineural hearing loss was found in 30.4% of their patients. Samir et al. [21] studied 34 children with CRF; 27 on regular HD and 7 on conservative treatment. Twenty normal healthy children served as controls. OAE testing was failed in 11.1% of patients on HD but in none of the patients on conservative

Table 1
General data in different studied groups.

Variable	Dialytic patients ($n = 25$)	Nondialytic patients ($n = 25$)	Controls ($n = 25$)
Gender (male)	18 (%72)	16 (%64)	16 (%64)
Age (year)	9.98 ± 3.19 (4–16, 10)	8.72 ± 3.09 (3–14, 9)	8.56 ± 2.97 (3.5–14, 9)
Height (cm)	121.04 ± 17.39 (92–158, 124)	109.44 ± 25.83 (90–140, 112)	124.80 ± 17.22 (95–155, 125)
Weight (kg)	24.62 ± 7.79 (13–41, 26)	21.32 ± 7.15 (11–40, 20)	23.98 ± 5.95 (14–32, 25)
SBP (mm Hg)	146.60 ± 17.72 (110–180, 150)	115.80 ± 20.50 (90–170, 110)	103.40 ± 10.77 (85–120, 100)
DBP (mm Hg)	93.80 ± 10.13 (70–110, 95)	69.40 ± 14.24 (50–110, 70)	66.20 ± 8.45 (50–80, 65)
BUN (mg/dl)	120.24 ± 20.87 (89–165, 114)	71.44 ± 18.82 (43–110, 65)	17.38 ± 3.97 (10–25, 18)
Creatinine (mg/dl)	7.18 ± 0.93 (5.1–8.9, 7.3)	3.03 ± 1.14 (1.6–6.9, 2.8)	0.66 ± 0.12 (0.5–0.9, 0.65)
Na (meq/l)	130.60 ± 2.81 (126–138, 130)	136.28 ± 4.97 (123–145, 137)	140.48 ± 3.81 (134–148, 139)
K (meq/l)	5.69 ± 0.55 (3.9–6.3, 5.8)	4.86 ± 0.65 (3–6.1, 4.8)	4.57 ± 0.40 (3.8–5.2, 4.5)
GFR	8.46 ± 1.53 (6.1–12.6, 8.20)	21.41 ± 6.89 (12–28.7, 19.1)	95.87 ± 13.85 (77.7–142, 94.54)

BUN: blood urea nitrogen, DBP: diastolic blood pressure, GFR: glomerular filtration rate (ml/min/1.73 m^2 body surface area), SBP: systolic blood pressure. Data are shown as mean ± standard deviation (range, median) or frequency (percent).