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# Vestibular dysfunction in adolescents and young adults after kidney transplant

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## Abstract

**Introduction:** Chronic kidney disease is a slowly progressive disease that causes irreversible loss of renal function and is considered a public health problem worldwide. **Objective:** To evaluate the vestibular behavior in patients with chronic kidney disease undergoing renal transplantation. Methods: A retrospective cross-sectional study was performed. Thirty patients were evaluated, 33.3% female and 66.7% male (mean age 16.9 (± 3.6) years old). Patients underwent the following procedures: anamnesis, ENT (ear, nose, and throat) evaluation and vestibular evaluation. **Results:** The patients reported dizziness when they were on dialysis. 50% the patients showed an abnormality in the vestibular test, which occurred in the caloric test. The abnormality was more prevalent in the peripheral vestibular system and there was a predominance of deficit peripheral vestibular disorders. **Conclusion:** The dizziness was the most significant symptom for the vestibular test in correlation with neurotological symptoms. Alteration in the vestibular exam occurred in the caloric test, there was a prevalence of alterations for the peripheral vestibular system with a predominance of deficit vestibular dysfunction. We emphasize the need to show professionals involved in patients with chronic kidney disease, those undergoing renal transplant and dialitic treatment the importance of prevention and early identification of otoneurological involvement.

**Keywords:** electronystagmography, kidney, kidney failure, chronic, kidney transplantation, vestibular function tests.

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## INTRODUCTION

Chronic kidney disease (CKD) is a slowly progressive disease that causes irreversible loss of renal function and is considered a public health problem worldwide[1]. The prevalence of patients with CKD in Brazil nearly doubled in the last eight years, and the incidence of new cases grows about 8% per year[2].

In 2006, the Brazilian Society of Nephrology (BSN) reported a prevalence of 383 dialysis patients per million of population in Brazil, 90% in hemodialysis and 10% in peritoneal dialysis[3].

Early diagnosis of CKD is related to better prognosis, prevents complications and reduces comorbidities[2].

Ototoxic drugs, particularly aminoglycoside antibiotics, can cause irreversible damage to hair cells of the spiral organ due to the formation of complex substances derived from the reactivity between the drug and the cell membrane phosphoinositides. The release of oxygen free radicals is also related to the ototoxicity of several drugs[4]. The kidney and the cochlear duct have anatomical, physiological, immunological and pathological similarities. The renal glomerulus and renal tubules have similar characteristics to the stria vascularis. For this reason, many nephrotoxic drugs may also be ototoxic[5,6].

Due to the proximity of the structures responsible for hearing and vestibular function, patients often experience changes in both systems. However, complaints of disequilibrium are not observed in all cases[7].

The vestibular organ is responsible for sensations of body balance, being of fundamental importance in the spatial relationship between organism and environment. For balance to occur appropriately it is necessary a perfect integration between the vestibular organ, auditory and visual system, and proprioceptive sensitivity[7].

Peritoneal dialysis, hemodialysis and renal transplantation are important procedures in the treatment of patients with chronic renal failure. Both dialysis and transplantation may result electrolyte, osmotic, biochemical, vascular and immune abnormalities in inner ear, causing cochlear and vestibular manifestations such as tinnitus, vertigo and hearing loss[8].

The aim of this research was to evaluate the vestibular behavior in patients with chronic kidney disease undergoing renal transplantation.

## PATIENTS AND METHOD

We analyzed data from 30 patients, 20 (66.7%) male and 10 (33.3%) female, from 13 to 26 years-old (mean age 16.9 (± 3.6), with CKD of different etiologies (Table 1), who had undergone a renal transplantation. Patients were evaluated at the Otoneurology Research Center.

**Table 1.** List of age and base disease of patients subjected to kidney transplantation.

| Patient | Age (years) | Base Disease |
|---|---|---|
| 1 | 17 | Posterior urethral valve |
| 2 | 19 | Hypertensive nephropathy |
| 3 | 18 | Hemolytic uremic syndrome |
| 4 | 14 | Hemolytic uremic syndrome |
| 5 | 16 | Autossomal dominant polycystic kidney disease |
| 6 | 17 | Hemolytic uremic syndrome |
| 7 | 16 | Hemolytic uremic syndrome |
| 8 | 15 | Multicystic kidney |
| 9 | 20 | Posterior urethral valve |
| 10 | 14 | Systemic lupus erythematosus |
| 11 | 13 | Glomerulonephritis |
| 12 | 13 | Posterior urethral valve |
| 13 | 25 | Posterior urethral valve |
| 14 | 13 | Posterior urethral valve |
| 15 | 16 | Neurogenic bladder |
| 16 | 13 | Cystinosis |
| 17 | 17 | Posterior urethral valve |
| 18 | 20 | Glomerulonephritis |
| 19 | 26 | Bladder exstrophy |
| 20 | 20 | Posterior urethral valve |
| 21 | 24 | Reflux nephropathy |
| 22 | 14 | Hemolytic uremic syndrome |
| 23 | 11 | Posterior urethral valve |
| 24 | 17 | Obstructive uropathy |
| 25 | 19 | Glomerulonephritis |
| 26 | 19 | Prunne belly syndrome |
| 27 | 16 | Posterior urethral valve |
| 28 | 16 | Unknown |
| 29 | 17 | Posterior urethral valve |
| 30 | 13 | Urogenital sinus |

The research was approved by the Human Research Ethics Committee from Pequeno Príncipe Hospital, Brazil (Register Number: 0715-09). All patients or legal responsible signed a consent form.

The duration of dialysis prior to renal transplantation ranged from one to 13 years (mean 6.7 (± 3.8)). Eight patients were treated with peritoneal dialysis, 17 with hemodialysis, and five with both.

The mean length of hospitalization in males and female ranged from 5 to 120 days. The follow-up post-transplant in males ranged between 0.5 and 9 years and females ranged from 2 to 8 years (mean 4.4 ± 2.2 years).

Regarding the type of donor for renal transplantation, 21 were from living donors and nine from deceased

donors. All patients had undergone renal transplant, regardless the underlying renal disease, time and type of previous treatment, and donor type.

Patients with mental, visual, musculoskeletal impairments, with ear diseases were excluded. The patients had kidney transplant for a minimum of five months and a maximum of 13 years.

A questionnaire to obtain otoneurological symptoms and personal and family information was applied (protocol developed by the Department of Otoneurology, Tuiuti University of Paraná.

Patients undertook a special diet, starting 72 hours before the otoneurological exams (abstaining from the intake of coffee, any kind of soda or caffeinated tea, chocolate, smoke, or alcohol). Analgesics, tranquilizers, and antihistaminic and antivertigo medications were suppressed during this period to minimize possible interferences with the test results. Three hours of fasting was recommended prior to the exam.

Vestibular function evaluation is composed of many labyrinthine function and ocular tests. The first part of our patients' evaluation was simply clinical and consisted of a systematic search for spontaneous, gaze, and positional nystagmus. The second part consisted of interpretation of the ENG test results, which is the objective register of the variations in the corneoretinal potentials, captured by sensitive electrodes. The ENG test is composed of: calibration of the ocular movements, search for spontaneous and gaze nystagmus, the oscillatory tracking test, optokinetic nystagmus search, and rotatory and caloric tests.

**Clinical Evaluation**

The search for positional nystagmus and vertigo was verified through Brandt and Daroff's maneuver[9]. Patients were requested to remain seated with the head and neck bent and the body tilted to the side, which evokes the vertigo; the head was then positioned 45 degrees in the opposite direction, and the neck rested on a horizontal plane at the final position. Patients returned to the first position and repeated the procedure toward the opposite side. The clinician searched for nystagmus for 30 seconds in each position.

The search for spontaneous nystagmus occurred without specific stimulation, with open and closed eyes. We searched for horizontal and vertical gaze nystagmus with 30-degree deviations (right, left, up, and down).

**ENG Registers**

We performed ENG with three-channel equipment (Berger Eletromedicina, model VN316, made in São Paulo, SP, Brazil).We cleaned the periorbital region with alcohol and placed the electrodes with electrolytic paste at the lateral angle of each eye and in the midpoint of the frontal line, forming a triangle and enabling the register of horizontal, vertical, and oblique ocular movements.

We performed tests with a rotating chair (Ferrante, model COD 14200, made in São Paulo, SP, Brazil), a visual stimulator (Neurograff Eletromedicina, model EV VEC, São Paulo, SP, Brazil), and an air caloric stimulator (Neurograff Eletromedicina, model NGR 05, São Paulo, SP, Brazil).

We made the following eye and labyrinth tests at ENG:

(a) calibration of eye movements to assess the regularity of the trace; (b) analysis of spontaneous nystagmus (eyes open and closed) and semi-spontaneous (eyes open) to evaluate the occurrence, direction, inhibiting effect of ocular fixation (IEOF) and the maximum slow component angular velocity (MSCAV) of the nystagmus;(c) pendular eye tracking test to assess occurrence of nystagmus and its curve type; (d) evaluation of optokinetic nystagmus at a velocity of 60° per second, in counterclockwise and clockwise in the horizontal direction. We evaluated the occurrence, direction and maximum MSCAV of the nystagmus; (e) search pre-rotatory and post-rotatory nystagmus by decreasing pendular rotation test, with stimulation of the lateral semicircular canals. For stimulation of the lateral semicircular ducts (horizontal) the head is flexed 30° forward. For evaluation of the anterior (or superior) semicircular ducts the head was positioned 60° backward and 45° to the right and for evaluation of the posterior semicircular ducts the head was positioned 60° backward and 45° to the left. It was observed the occurrence, direction, frequency of the nystagmus; (f) analysis of nystagmus pre-caloric and post-caloric, was performed with the patient tilted 60° backwards for adequate stimulation of the lateral semicircular ducts. The irrigation time of each ear with air at 42 °C, 18 °C and 10 °C lasting 80 seconds and the responses were recorded with open and closed eyes to observe the IEOF. We evaluated the direction, the absolute values of MSCAV of the nystagmus and the calculation of the ratio of directional preponderance (DP) and labyrinth predominance (LP) of post-caloric nystagmus[10].

We compared results with normal standards, obtained from epidemiological studies for the Brazilian population[11-13]. Table 2 shows the criteria used to analyze each test as well as to distinguish central from peripheral vestibulopathy.

The diagnosis of peripheral vestibulopathy is achieved by comparison with normal standards and the absence of pathognomonic signs of central vestibular alterations.

The data were analyzed by Fisher's exact test and Chi-square, searched for a statistically significant difference in ENG results, comparing the affected patients with those in the control group ($p < .05$).

**Table 2.** Normal standards and criteria used to analyze the vestibular tests and distinguish central from peripheral.

| | Normal Vestibular Exam | Peripheral Vestibular Exam | Central Vestibular Exam |
|---|---|---|---|
| Position nystagmus (Brandt & Daroff's maneuver) | Absent | Present (rotatory, horizontal rotatory, and oblique) with latency, paroxysm, weariness, and vertigo | Present (vertical inferior, superior, rotatory, horizontal rotatory, and oblique), without latency, paroxysm, weariness, and vertigo |
| Calibration of the ocular movements | Regular | Regular | Irregular (alterations in latency, accuracy, and velocity of the saccadic movements) |
| Spontaneous nystagmus | Present (< 7degrees/sec) with closed eyes; absent with open eyes | Present (> 7 degrees/sec) with closed eyes; absent with open eyes | Present with open eyes (vertical inferior, superior, rotatory, horizontal rotatory, oblique, cyclic, dissociated, and retractor) |
| Gaze nystagmus | Absent | Absent | Present, unidirectional, bidirectional, or mixed; presents a variety of nystagmus types |
| Oscillatory track | Types I and II | Type III | Type IV (pathognomonic); alterations of morphology and gain |
| Optokineticnystagmus | Symmetrical, < 20 degrees/sec | Asymmetrical, > 20 degrees/sec, having superposed spontaneous nystagmus with open eyes that justifies this alteration | Asymmetrical, > 20 degrees/sec, absent and reduced |
| Rotation test | < 33%, after stimulation of the lateral and superior semicircular ducts | > 33%, after stimulation of the lateral and superior semicircular ducts | > 33%, after stimulation of the lateral and superior semicircular ducts and absence of induced oblique nystagmus |
| Air caloric test | Absolute value: between 2 and 24 degrees/sec<br>Relative values:<br>Labyrinth preponderance < 41%<br>Nystagmus directional preponderance < 36% | Absolute value: < 2 degrees/sec (hyporeflexia), > 24 degrees/sec (hyperreflexia) and areflexia<br>Relative values:<br>Labyrinth preponderance > 41%<br>Nystagmus directional preponderance > 36% (Jongkees formula) | Absolute value: < 2 degrees/sec (hyporeflexia), > 24 degrees/sec (hyperreflexia) and areflexia<br>Relative values:<br>Labyrinth preponderance > 41%<br>Nystagmus directional preponderance > 36% (Jongkees formula).<br>Different nystagmus types may be observed: dissociated, inverted, perverted, and absence of the fast component of the nystagmus |
| Inhibiting effect of ocular fixation | Present | Present | Absent |

Based on Padovan & Pansini[11], Mangabeira-Albernaz et al.[12], and Ganança et al.[13].

## RESULTS

The patients showed no vestibular complaints during the anamnesis. They mentioned dizziness only when they were performing the dialysis.

The studies on positional/positioning nystagmus, eye movement calibration, investigation of spontaneous nystagmus with eyes open and closed, semi-spontaneous nystagmus, pendular tracking tests and optokinetic nystagmus showed no alterations.

For the caloric test, fourteen cases (46.7%) of labyrinthine hyporeflexia and one case (3.3%) of LP altered.

Fifteen cases (50%) had peripheral vestibular system and there was a predominance of deficit peripheral vestibular disorders, with seven bilateral cases (23.3%) and eight unilateral cases (26.7%).

The test was normal in 15 cases (50%). Although not as significant in the statistical study, 50% of patients showed abnormalities in vestibular exam and this result was important.

The relationship between gender (Table 3), age (Table 4) or time of dialysis (Table 5) and ENG was not statistically significant. The relationship between the type of dialysis or the time after renal transplantation and ENG is described in Tables 6 and 7 respectively.

There was no statistically significant relationship between the donor type (living or deceased) and ENG ($p = 0.0543$).There was no relationship between length of hospital stay after transplantation (less or more than 20 consecutive days) and ENG ($p = 0.4561$).

The relationship between the duration and cause of the renal disease with the result of the ENG testing are described in Tables 8 and 9, respectively.

There was no statistical significance between disease duration and the results of the ENG ($p = 0.2320$).

## DISCUSSION

Clinical manifestations of vestibular disorders are relatively frequent in patients with CKD on dialysis.

**Table 3.** Relationship between sex and electronystagmography in patients subjected to kidney transplantation.

| Exam and Sex | Exam Result | | *p* | Test |
|---|---|---|---|---|
| | Hyporeflexia | Normorreflexia | | |
| CT | | | | |
| Male | 10 | 4 | 0.4500 | Fisher |
| Female | 10 | 6 | | |
| | NVE | DPVD | *p* | TEST |
| ENG | | | | |
| Male | 10 | 10 | 1.0000 | Chi-square |
| Female | 5 | 5 | | |

CT: Caloric test; ENG: Electronystagmography; NVE: Normal vestibular exam; DPVD: Deficit peripheral vestibular dysfunction.

**Table 4.** Relation between the age and the electronystagmography in patients subjected to kidney transplantation.

| Exam and Age (years) | Exam Result | | *p* | Test |
|---|---|---|---|---|
| | Hyporeflexia | Normorreflexia | | |
| CT | | | | |
| Under 17 | 7 | 7 | 1.0000 | Chi-square |
| 17 or above | 8 | 8 | | |
| | NVE | DPVD | *p* | Test |
| ENG | | | | |
| Under 17 | 8 | 7 | 0.7150 | Chi-square |
| 17 or above | 7 | 8 | | |

CT: Caloric test; ENG: Electronystagmography; NVE: Normal vestibular exam; DPVD: Deficit peripheral vestibular dysfunction.

**Table 5.** Relation between the amount of time under dialysis and the electronystagmography in patients subjected to kidney transplantation.

| Exam and Treatment Duration (years) | Exam Result | | *p* | Test |
|---|---|---|---|---|
| | Hyporeflexia | Normorreflexia | | |
| CT | | | | |
| Under 7 | 7 | 7 | 0.7321 | Chi-square |
| 7 or above | 7 | 9 | | |
| | NVE | DPVD | *p* | Test |
| ENG | | | | |
| Under 7 | 7 | 7 | 1.0000 | Chi-square |
| 7 or above | 8 | 8 | | |

CT: Caloric test; ENG: Electronystagmography; NVE: Normal vestibular exam; DPVD: Deficit peripheral vestibular dysfunction.

However, in our research the complaints of dizziness were reported only during the dialysis treatment. In the 1960, Yassin et al.[14] reported that 47.6% of dialysis patients complained of vertigo. Several authors from the mid-1970s demonstrated that CKD patients often had otological symptoms such as tinnitus, dizziness and hearing loss[5,15]. In the 2010s, Terra et al.[16] reported that 41.3% of hemodialysis patients complained of dizziness and 2011s, Caplin et al.[17] reported vertigo in 63%.

**Table 6.** Relation between the type of dialysis and the electronystagmography in patients subjected to kidney transplantation.

| Exam and type of treatment | Exam Result | | *p* | Test |
|---|---|---|---|---|
| | Hyporeflexia | Normorreflexia | | |
| CT | | | | |
| Pritoneal dialysis | 5 | 3 | 0.2860 | Fisher |
| Hemodialysis | 7 | 10 | | |
| Hemodialysis/ Peritoneal dialysis | 3 | 2 | | |
| | NVE | DPVD | *p* | Test |
| ENG | | | | |
| Peritoneal dialysis | 5 | 3 | 0.2860 | Fisher |
| Hemodialysis | 7 | 10 | | |
| Hemodialysis/ Peritoneal dialysis | 3 | 2 | | |

CT: Caloric test; ENG: Electronystagmography; NVE: Normal vestibular exam; DPVD: Deficit peripheral vestibular dysfunction. For applying Fisher test, only two categories of results were considered: peritoneal dialysis and hemodialysis (the most frequent).

**Table 7.** Relation between the amount of time of kidney transplantation and electronystagmography.

| Exam and Transplantation Time (years) | Exam Result | | *p* | Test |
|---|---|---|---|---|
| | Hyporeflexia | Normorreflexia | | |
| CT | | | | |
| Under 5 | 6 | 8 | 0.5104 | Chi-square |
| 5 or above | 5 | 11 | | |
| | NVE | DPVD | *p* | Test |
| ENG | | | | |
| Under 5 | 5 | 6 | 0.7048 | Chi-square |
| 5 or above | 10 | 9 | | |

CT: Caloric test; ENG: Electronystagmography; NVE: Normal vestibular exam; DPVD: Deficit peripheral vestibular dysfunction.

**Table 8.** Relationship between duration of illness and electronystagmography in kidney disease patients with renal transplants.

| Duration of Illness (years) | Exam Result | | *p* | Test |
|---|---|---|---|---|
| | Abnormal | Normal | | |
| Less than 5 | 3 | 6 | | |
| 5-9 | 9 | 4 | 0.2320 | Chi-square |
| 9 or more | 3 | 5 | | |

Fifteen (50%) of our patients showed abnormalities on examination of the vestibular system. These results are consistent with several other researches that showed vestibular disorders in patients with CKD treated with

**Table 9.** Relationship between cause of kidney disease and the result of electronystagmography in patients with renal transplants.

| Cause of Illness | Exam result | | Total |
|---|---|---|---|
| | Abnormal | Normal | |
| Posterior urethral valve | 4 | 6 | 10 |
| Hypertensive nephropathy | - | 1 | 1 |
| Hemolytic uremic syndrome | 5 | - | 5 |
| Autossomal dominant polycystic kidney disease | - | 1 | 1 |
| Multicystic kidney | 1 | - | 1 |
| Systemic lupus erythematosus | 1 | - | 1 |
| Glomerulonephritis | 1 | 2 | 3 |
| Neurogenic bladder | - | 1 | 1 |
| Cystinosis | 1 | - | 1 |
| Bladder exstrophy | - | 1 | 1 |
| Reflux nephropathy | - | 1 | 1 |
| Obstructive uropathy | 1 | - | 1 |
| Prunne belly syndrome | 1 | - | 1 |
| Unknown | - | 1 | 1 |
| Urogenital sinus | - | 1 | 1 |

renal transplantation or dialysis for a long time. The frequency of vestibular disorders in CKD, with or without renal transplantation, ranges from 1.9% to 100%, with cases of central and peripheral disorders, with hyporeflexia and hyperreflexia[8,17,18-22].

The evaluation of the vestibular system is essential in the investigation of body balance, and caloric testing is very important, because it assesses the labyrinth separately.

In the present study, we observed an alteration in the peripheral vestibular system, identified in the caloric test, with a predominance of deficit dysfunction. Yassin et al.[14] demonstrated the presence of spontaneous nystagmus in five patients with CKD undergoing hemodialysis and kidney transplantation, and Guarrigues & Clemente[21] reported 63.1% of central vestibular disorders in individuals with CKD.

Deafness and balance disorders are directly related to the level of uremia[19]. The intensity of the clinical and histopathological findings is directly proportional to the time and type of treatment. Treatment for a long time can induce electrolyte, biochemical, vascular, osmotic and immune abnormalities. The longer the time on dialysis, the higher the risk of ear and vestibular disease[15].

In our research there were 15 (50%) cases of normal vestibular exam, 14 (46.7%) of labyrinth hyporeflexia and one case (3.3%) of LP altered. These values are consistent with other studies that found that hyporeflexia is more frequent than hyperreflexia[18,22]. Discordant results were observed by Yassin et al.[14].

The relationship between the gender of the patients and the results of ENG showed no significant values. There is no comparing data in the literature. The relationship between the age of the patients and ENG was not statistically significant.

There was no statistically significant correlation between the duration of the kidney disease, type and duration of dialysis treatment with vestibular tests. Yassin et al.[14] reported that 37.5% of patients with chronic kidney disease who performed over 264 sessions of dialysis or were transplanted had vestibular dysfunction. Regarding the duration of kidney disease, we did not find this comparison in the accepted literature so that we could compare our findings.

The relationship between the time of renal transplantation and ENG was not significant. However, post-transplant patients need otologic follow-up, because the immunosuppressive drugs (cyclosporine and corticosteroids) can cause change in plasma viscosity inside the inner ear[23].

Sazgar et al.[24] performed the examination of vestibular evoked myogenic potentials (VEMP) in 22 patients undergoing hemodialysis and observed alteration in creatinine level and absence of waves when compared to a control group.

In accordance with the authors in the accepted literature, we observe an uncertainty with respect to the cause of labyrinthine dysfunction since they formulated several hypotheses. Among these reasons are the duration of kidney disease, type and prolonged use of dialysis, use of ototoxic medications pre- and post-renal transplant, high levels of urea and/or serum creatinine, and even unknown causes. Perhaps one or more of these factors may be the explanation of the labyrinthine alterations evidenced in the present study. Therefore, we suggest monitoring this type of population so that we can do deeper future clinical research.

## CONCLUSION

Dizziness was the most significant symptom for the vestibular test in correlation with neurotological symptoms.

Alteration in the vestibular exam occurred in the caloric test, there was a prevalence of alterations for the peripheral vestibular system with a predominance of deficit vestibular dysfunction.

We emphasize the need to show professionals involved in patients with CKD, those undergoing renal transplant and dialitic treatment the importance of prevention and early identification of otoneurological involvement. These patients should periodically perform labyrinth exam to prevent future abnormalities of the vestibular system.

## REFERENCES


1. Alport AC. Hereditary familial congenital hemorrhagic nefhritis. Br Med J. 1927;1(3454):504-6. DOI: http://dx.doi.org/10.1136/bmj.1.3454.504
2. Romão JER. Doença renal crônica: definição, epidemiologia e classificação. J Bras Nefrol. 2004;26(3 Suppl 1):1-3.
3. SBN - Sociedade Brasileira de Nefrologia. Censo dos centros de diálise no Brasil 2004/2005 [Acesso 03 Nov. 2013]. Disponível em: http://www.sbn.org.br/Censo/censo20042005.htm.
4. Matz GJ, Naunton RF. Ototoxic drugs and poor renal function. JAMA. 1968;206(9):2119. DOI: http://dx.doi.org/10.1001/jama.1968.03150090195037
5. Thomsen J, Bech P, Szpirt W. Otologic symptoms in chronic renal failure. The possible role of aminoglycoside-furosemide interaction. Arch Otorhinolaryngol. 1976;214(1):71-9. DOI: http://dx.doi.org/10.1007/BF00455110
6. Quick CA, Fish A, Brown C. The relationship between cochlea and kidney. Laryngoscope. 1973;83(9):1469-82. DOI: http://dx.doi.org/10.1288/00005537-197309000-00007
7. Caovilla HH, Ganança MM, Munhoz MSL, Silva MLG, Ganança FF. Presbivertigem, Presbiataxia, Presbizumbido e Presbiacusia. In: Silva MLG, Munhoz MSL, Ganança MM, Caovilla HH. Quadros clínicos otoneurológicos mais comuns. São Paulo: Atheneu; 2000. p.153-8.
8. Zeigelboim BS, Fukuda Y. Alterações vestíbulo-cocleares em pacientes portadores de insuficiência renal crônica submetidos à hemodiálise e transplante renal. Rev Bras Med Otorrinolaringol. 1997;4(4):120-4.
9. Brandt T, Daroff RB. Physical therapy for benign paroxysmal positional vertigo. Arch Otolaryngol. 1980;106(8):484-5. DOI: http://dx.doi.org/10.1001/archotol.1980.00790320036009
10. Jongkees LBW, Philipszoon AJ. Electronystagmography: the caloric test. Acta Otolaryng. 1964;57(s189):45-54. DOI: http://dx.doi.org/10.3109/00016486409134643
11. Padovan I, Pansini M. New possibilities of analysis in electronystagmography. Acta Otolaryng. 1972;73:121-5. DOI: http://dx.doi.org/10.3109/00016487209138920
12. Mangabeira-Albernaz PL, Ganança MM, Pontes PAL. Modelo operacional do aparelho vestibular. In: Mangabeira-Albernaz PL, Ganança MM. Vertigem. 2a ed. São Paulo: Moderna; 1976. p.29-36.
13. Ganança CC, Souza JAC, Segatin LA, Caovilla HH, Ganança MM. Normal limits of evaluation parameters of neurograff digital vectonystagmography [in Portuguese]. Acta AWHO. 2000;19(2):105.
14. Yassin A, Safwat F, Fatt-Hi A. Ear, nose and throat manifestations in cases of renal failure treated by dialysis. Hemodialysis and peritoneal dialysis. Ann Otol Rhinol Laryngol. 1966;75(1):192-201. DOI: http://dx.doi.org/10.1177/000348946607500116
15. Oda M, Preciado MC, Quick CA, Paparella MM. Labyrinthine pathology of chronic renal failure patients treated with hemodialysis and kidney transplantation. Laryngoscope. 1974;84(9):1489-506. DOI: http://dx.doi.org/10.1288/00005537-197409000-00005
16. Terra FS, Costa AMDD, Figueiredo ET, Mo¬rais AM, Costa MD, Costa RD. As principais complicações apresentadas pelos pacientes renais crônicos durante as sessões de hemodiálise. Rev Bras Clin Med. 2010;8(3):187-92.
17. Caplin B, Kumar S, Davenport A. Patients' perspective of haemodialysis-associated symptoms. Nephrol Dial Transplant. 2011;26(8):2656-63. DOI: http://dx.doi.org/10.1093/ndt/gfq763
18. Miller GW, Joseph DJ, Cozad RL, McCabe BF. Alport's syndrome. Arch Otolaryngol. 1970;92(5):419-32. DOI: http://dx.doi.org/10.1001/archotol.1970.04310050001001
19. Traserra J, Caralps A. Uremic cochleo-vestibular pathology and renal transplantation. Acta Otorinolaryngol Iber Am. 1972;23(1):60-89.
20. Kusakari J, Kobayashi T, Rokugo M, Arakawa E, Ohyama K, Kawamoto K, et al. The inner ear dysfunction in hemodialysis patients. Tohoku J Exp Med. 1981;135(4):359-69. DOI: http://dx.doi.org/10.1620/tjem.135.359
21. Pérez Garrigues H, Marco Clemente J. Chronic renal insufficiency and the auditory system [Article in Spanish]. An Otorrinolaringol Ibero Am. 1987;14(6):635-44.
22. Misra A, Dash SC, Deka RC, Malhotra KK. Vestibular functions in conservatively treated chronic renal failure. J Assoc Physicians India. 1989;37(2):189-91.
23. Sefer S, Trotić R, Lacmanović V, Degoricija V, Ratković-Gusić I, Kes P. Effects of renal transplantation on hearing and ocular changes in a monozygotic twin with Alport's syndrome: comparison with other twin on hemodialysis. Croat Med J. 2000;41(2):203-6.
24. Sazgar AA, Ahmadi F, Akrami K, Akrami S, Abbasi MR, Rasool F. Vestibular evoked myogenic potentials of haemodialysed patients with end stage renal disease. Eur Arch Otorhinolaryngol. 2008;265(4):393-6. DOI: http://dx.doi.org/10.1007/s00405-007-0457-z