e-ISSN: 0975-1556, p-ISSN:2820-2643

Available online on www.ijpcr.com

International Journal of Pharmaceutical and Clinical Research 2023; 15(4); 1151-1156

Original Research Article

A Study of Vestibular Dysfunction in Patients with Chronic Kidney Disease

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Received: 04-02-2023 / Revised: 06-03-2023 / Accepted: 02-04-2023
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Conflict of interest: Nil

Abstract

Introduction: Chronic kidney disease is a slowly progressive disease that causes irrevocable loss of renal function and is considered a public health problem worldwide. CKD patients can be treated by peritoneal dialysis, haemodialysis and kidney transplantation. These may result in electrolyte, biochemical, osmotic, vascular and immunological abnormalities in the inner ear causing vestibular and cochlear manifestations like tinnitus, vertigo and decreased hearing. Therefore the aim of this study was to determine association of chronic kidney disease (CKD) with vestibular dysfunction in a general population.

Methods: 60 CKD patients were evaluated in this study. The data collected from the participants included age, gender, an estimated glomerular filtration rate (eGFR), CKD stage, CKD etiology, whether on ototoxic drugs or not, whether on dialysis or not. Video Head Impulse Test (vHIT) performed on these patients.

Results: The number of participants with vestibular dysfunction was 2 out of 60, that is 3.3%. These participants were found to have reduced VOR Gain i.e. abnormal vHIT. Both of them showed the presence of corrective saccades.

Conclusions: CKD was not found to be associated with vestibular dysfunction in our study. Considering the limitations of this study, further studies are required to evaluate the relation of CKD with vestibular dysfunction.

Keywords: Chronic Kidney Disease, Vestibular dysfunction, Video head impulse test.

Introduction

The nephron and the cochlear duct have anatomical, physiological, pathological and immunological similarities i.e. renal glomerulus and tubules have alike characteristics to that of the stria vascularis. That's why, numerous nephrotoxic drugs can also be ototoxic. [1]

By consuming nephrotoxic drugs, patients may develop chronic kidney disease and may experience the disturbance in ears.

The structures responsible for hearing and balance are present in proximity, therefore patients may feel a disturbance in both the systems. However, complaints of imbalance are not observed in all cases.[2]

CKD patients can be treated by peritoneal dialysis, haemodialysis and kidney transplantation. These may result in electrolyte, biochemical, osmotic, vascular and immunological abnormalities in the inner ear causing vestibular and cochlear manifestations like tinnitus, vertigo and decreased hearing.[3]

Therefore, we aimed to evaluate the vestibular behaviour in patients with CKD.

The purpose of vestibular evaluation is to check whether the vestibular system is functioning properly or not. To check the Stabilization of gaze, the Perfect perception of horizontal and vertical, Stabilization of posture, Functional and structural integrity of the vestibular reflex arc.[4]

There are following tests available for the evaluation of the peripheral vestibular system-

Video-nystagmography (VNG): It consists of Spontaneous nystagmus test, Saccade test, Smooth pursuit test, Optokinetic test, Gaze test, Positional tests and the Caloric test. It evaluates the Vestibulo ocular reflex, Lateral Semi-circular canals, the Oculomotor system and superior vestibular nerve.

Subjective Visual Vertical (SVV): This test evaluates the otolithic system and the perception of visual vertical.

Dynamic Visual Acuity (DVA): This test evaluates the ability of maintaining stable vision when the head is moving. Hence it checks the Vestibulo ocular reflex.

Cranio-corpography (CCG): This test evaluates the Vestibulo spinal reflex.

Stabilometry: This test evaluates the Vestibulo spinal reflex and the stability.

Video Head Impulse Test (vHIT): This test evaluates the Vestibulo ocular reflex of all 6 SCCs.

In our study, vHIT was performed in patients with CKD.

Methods

This was a cross-sectional observational study on patients suffering from chronic kidney disease and who were referred to the Department of Otorhinolaryngology from the Department of Nephrology, between January 2021 to December 2021. All patients suffering from chronic kidney disease with age equal to or greater than 18 years were included in the study. Bedridden patients, patients with cervical problems and those with the right blind eye were excluded from the study. Informed consent was taken from all the patients and study was approved by the Institutional ethical committee.

Data was collected from patients using a case proforma. Clinical examination was done thoroughly before the test including the ear examination with and without ear speculum.

The video head impulse test was done in a room with bright light to maintain miotic pupil. The patient was made to sit on an adjustable chair approximately one meter from the target. Test was done using Monocular Video Frenzel goggles. The goggles had an inbuilt high speed USB camera and a nine axis motion sensor which detects the right eye movement. The goggles were secured snugly and connected to the computer. After that calibration was done to assess the saccadic eye movement of the patient. The computer data acquisition program tracks the centre of the pupil. The patient was asked to keep his/her eyes wide open and not to blink during head thrust. The head thrust was given with high velocities – at least 150 degree/sec upto 300 degree/sec and high acceleration- 750-6000 degree/sec^2. The operator move the patient's head in a sudden, unforeseeable, lateral head turn and stops suddenly about 10- 15 degree from midline.

For testing of the vertical canals- LARP (Left anterior right posterior) and RALP (Right anterior left posterior), the patient's gaze must be kept parallel with the plane of the canal being tested and the head impulse given in the vertical axis. During the impulse, the patient was asked to keep looking at the target on the wall in front of them and if they lose the target, to return their eyes to the target as quickly as possible. The standard 20 impulses on each side were given.

The canal affected with individual mean VOR of each canal with presence or absence of saccades was recorded for all patients. We used a computer based software of Neuro-equilibrium diagnostic systems, India for vHIT.

The vHIT results were evaluated on three parameters: a) VOR gain- for lateral canal 80- 100% is normal while for vertical canal 70- 100% is normal. b) The presence or absence of saccades- consistency, latency, amplitude and direction. c) The shape of the eye position or eye velocity tracing.

Once the data entry was completed, statistical analysis was carried out using Microsoft office 365. The data was presented as numbers (percentage). The suitable statistical test was used to analyse the data. P-value < 0.05 was considered significant.

Results

60 patients were analyzed during the study period of 1 year. In the present study maximum number of patients (61.7%) belong to 18-30 years. There were 51.7% males and 48.3% females in our study.

Maximum number of subjects belong to CKD Stage V (31.7%) (Table 1), had hypertension (41.7%).

Table 1: Distribution of study subjects according to CKD staging

CKD Stage	Frequency	Percentage
I	3	5
II	11	18.3
III	11	18.3
IV	16	26.7
V	19	31.7
Total	60	100

Only 16.7% patients were taking ototoxic drugs (Table 2) and 30% were on dialysis.(Table 3)

Table 2: Distribution of study subjects taking ototoxic drugs

On ototoxic drugs	Frequency	Percentage
YES	10	16.7
NO	50	83.3
Total	60	100

Table 3: Distribution of study subjects on dialysis

On Dialysis	Frequency	Percentage
YES	18	30
NO	42	70
Total	60	100

Relationship between VOR gain of study subjects was compared with various parameters like age, sex, CKD staging, etiology of CKD, Ototoxic drug intake and treatment by dialysis.

Only 2 patients out of 60 i.e. 3.3% were found to have vestibular dysfunction. Both of these patients were of Stage V CKD, one having estimated GFR (eGFR) 2ml/min/1.73m^2 and other having eGFR of 4ml/min/1.73m^2. (P-value= 0.347). (Table 4)

Table 4: Relation between VOR Gain and CKD Staging of study subjects.

Stages	Normal VOR Gain	Low VOR Gain	Total
I	3	0	3
II	11	0	11
III	11	0	11
IV	16	0	16
V	17	2	19
Total	58	2	60
P value	0.347		

Only 1 patient who had vestibular dysfunction, consumed ototoxic drugs. (P-value= 0.198). (Table 5)

Table 5: Relation between VOR Gain and Ototoxic drug intake in study subjects.

On ototoxic drugs	Normal VOR Gain	Low VOR Gain	Total
Yes	9	1	10
No	49	1	50
Total	58	2	60
P value	0.198		

Only one participant was found to be on dialysis who had vestibular dysfunction. (P- value= 0.53). (Table 6)

Table 6: Relation between VOR Gain of study subjects and their treatment by dialysis.

On Dialysis	Normal VOR Gain	Low VOR Gain	Total
Yes	17	1	18
No	41	1	42
Total	58	2	60
P value	0.53		

None of the above parameters were found to have a statistically significant relationship with reduced VOR gain.

Discussion

After proper history taking and clinical examination, vHIT was performed on 60 patients suffering from Chronic kidney disease.

All patients were analysed by video head impulse test results to evaluate whether the vestibular system gets affected in patients with CKD. Each semi-circular canal was assessed and VOR gain calculated. The presence of saccades was also recorded and evaluated.

The study sample consisted of male and female patients in approximately equal numbers. The male to female ratio was 31:29.

All 60 patients were subjected to vHIT for the vestibular system evaluation.

The presence of saccades (both covert and overt) is considered to be abnormal.

The number of participants with Stage I, II, III, IV, V CKD were 3,11,11,16,19 respectively.

Only 2 patients out of 60 i.e. 3.3% were found to have vestibular dysfunction.

Both of these patients were of Stage V CKD, one having a estimated GFR (eGFR) 2ml/min/1.73m^2 and other having eGFR of 4ml/min/1.73m^2. (P-value= 0.347).

Only 1 patient who had vestibular dysfunction, consumed ototoxic drugs. (P-value= 0.198). In 1989, Misra A, Dash SC, Deka RC, Malhotra KK concluded in their study that ototoxic drugs like furosemide may be the most important factor in aetiology of vestibular dysfunction in chronic renal failure.[5]

In our study, only one participant was found to be on dialysis who had vestibular dysfunction. (P- value= 0.53). In 1966, Yassin A, Safwat F, Fatt-Hi A reported that 37.5% of patients with chronic kidney disease who were on dialysis/were transplanted had vestibular dysfunction. It was also reported that 47.6% of dialysis patients complained of vertigo.[6]

In 1974, Oda M, Preciado MC, Quick CA, Paparella MM published a study in which labyrinthine pathology of patients with chronic renal failure who are treated with haemodialysis and kidney transplantation was investigated. They concluded that numerous hemo-dialyses or recurrent kidney transplants can induce electrolytic, osmotic, biochemical, vascular and/or immunological changes in the inner ear which can lead to severe auditory and vestibular symptoms and pathology.[7]

Klagenberg *et al* (2013) conducted a study to assess the vestibular behaviour in patients with chronic kidney disease undergoing renal transplantation. They concluded that dizziness was the most significant symptom for the vestibular test in correlation with neuro-otological symptoms. They emphasized the need to show professionals involved in patients with chronic kidney disease, those undergoing renal transplant and dialysis treatment the importance of prevention and the early identification of oto-neurological involvement.[8]

In our study, the participants who had vestibular defect, were found to have reduced VOR Gain and both of them showed the presence of corrective saccades.

According to a study conducted by Jung DJ, Lee KY, Do JY *et al* (2017), CKD was found to be significantly associated with vestibular dysfunction in the general population. They concluded that the participants with CKD may be closely monitored for vestibular dysfunction.[9]

This study has a following limitations.

1. It is a cross-sectional study; no follow up testing was done. Hence the development of vestibular dysfunction in later stages could not be ruled out.
2. Sample size is small which reduced the number of observations.
3. Pediatric population with CKD were not assessed.
4. We did not evaluate the hearing component to check if there was any cochlear dysfunction or not.
5. Vestibular dysfunction was assessed by vHIT alone i.e. only Vestibulo ocular reflex was tested. Other balance tests like VNG, CCG, Posturography etc. were not performed.

Conclusions

In conclusion, CKD was not found to be associated with vestibular dysfunction in our study. Considering the limitations of this study, further studies are required to evaluate the relation of CKD with vestibular dysfunction.

List of Abbreviations

CKD - Chronic Kidney Disease
vHIT - Video Head Impulse Test
eGFR - Estimated Glomerular Filtration Rate
VOR - Vestibulo Ocular Reflex
LARP - Left anterior right posterior
RALP - Right anterior left posterior
VNG - Video Nystagmography
CCG - Cranio Corpography

Ethical approval and consent to participate: Informed consent was taken from all the patients and study was approved by Institutional ethical committee of RNT Medical College & Attached Hospitals, Udaipur.

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