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RESEARCH

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Periodic limb movements among dialysis and non-dialysis chronic kidney disease patients: a comparative study

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Abstract

Background: Periodic leg movement disorder is defined as periodic episodes of repetitive limb movements during sleep that mainly occurs in the lower limb, including the hips, knees, and toes, and sometimes affects the upper limb. It may be accompanied by frequent nocturnal arousals, and if so, this sleep disturbance may cause excessive daytime sleepiness. Chronic kidney disease patients are at risk of periodic leg movements and common causes are iron deficiency, anemia, raised serum calcium, and central and peripheral nervous system disorders. This study aimed to screen the prevalence of periodic limb movements among chronic kidney disease patients using full-night attended polysomnography, compare dialysis with non-dialysis CKD patients, and correlate PLM prevalence with the HGB level and degree of renal impairment.

Results: This cross-sectional study was carried out on one hundred chronic kidney disease patients during the period between May 2017 and March 2020. The patients were subdivided into two groups: group I included patients on regular hemodialysis ($n = 50$), and group II included patients not on dialysis. All patients were screened for periodic limb movement using full-night attended polysomnography. Our study revealed a high prevalence of periodic limb movements in both groups of chronic kidney disease patients (60% in dialysis and 66% in non-dialysis patients) with mean PLM indices insignificantly higher in group I than group II (29.90 ± 19.19/h vs. 17.54 ± 13.56/h, *P*-value = 0.748). Moreover, there was a significant positive correlation between periodic leg movements and serum urea level (*r*-value = 0.38 and 0.33 and *P*-value = 0.04 and 0.030 in group I and group II consequently). Also, we reported a significant negative correlation between periodic leg movements and hemoglobin level ($r = -0.251$ and -0.291 and *P*-value = 0.037 and 0.010 in group I and group II consequently).

Conclusion: Periodic leg movement disorder is highly prevalent among CKD patients either on dialysis or not, and good management of renal dysfunction and anemia in those patients can help in the management of PLM.

Keywords: Periodic limb movements, Chronic kidney disease, Polysomnography

Background

Periodic leg movement (PLM) disorder is defined as periodic episodes of repetitive limb movements during sleep that mainly occurs in the lower limb, including the hips, knees, and toes, and sometimes affects the upper limb. It may be accompanied by frequent nocturnal awakening, and this sleep disturbance may cause excessive daytime sleepiness [1]. Chronic kidney disease (CKD) patients are at risk of PLM disorder and common causes are anemia, hypercalcemia, and central and peripheral nervous system disorders. Also, the change in opioid and dopaminergic activity within the nervous system may play a role [2]. It is significant to detect PLM disorders among CKD patients, as they may cause sleep disruption and fatigue. Also, PLM may be accompanied by sympathetic nocturnal hypertension and nervous system activity, which

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could add to the already increased risk of cardiovascular complications in CKD patients. Management of PLM disorder causes a reduction in the risk of cardiovascular disease and improves sleep quality [3]. PLM disorder can be detected by polysomnography as involuntary periodic leg movements during sleep. We conducted this study to screen the prevalence of periodic limb movements among chronic kidney disease patients using full-night attended polysomnography, compare dialysis with non-dialysis CKD patients, and correlate PLM prevalence with the HGB level and degree of renal impairment.

Patients and methods

This cross-sectional study was carried out on one hundred patients with known chronic kidney diseases in the period between May 2017 and March 2020. Patients with comorbidities like liver cell failure, chronic chest disease, and diabetes were excluded from the study. The patients were subdivided into two groups: group I included patients on regular hemodialysis ($n = 50$), and group II included patients not on dialysis. The patients were subjected to medical history including symptoms of sleep disorders and assessment of daytime sleepiness using the Epworth Sleepiness Scale (ESS), anthropometric assessment (weight, height, BMI), and renal function tests (serum creatinine and serum urea level). All participants were screened for PLMs using in-laboratory full-night polysomnography (PSG) which is the gold standard diagnostic test for the diagnosis of PLMs. PSG was carried out in the sleep unit of the Chest Department using Nihon Kohden's Polysmith Polysomnography with a full 10–20 montage, 8 bipolar inputs, 6 DC channels, bedside impedance checking, designated channels for electrooculogram (EOG), chin, and 3 electroencephalogram (EEG) channels with a dedicated reference. The PSG-100 amplifier has a built-in transducer and SPO2. We scored the PSG manually guided by the American Academy of Sleep Medicine guidelines (2017). PLM is scored when there is an 8-μV increase in electromyogram voltage above resting EMG and ends as the start of a period lasting at least 0.5 s during which the EMG is less than 2 μV above resting EMG. If PLMs occurred bilaterally but separated by less than 5 s between movements, onsets will be scored as a single leg movement. Leg movements that precede respiratory events by 0.5 s or less will not be scored as PLM. The normal recorded PLM is ≤ 4/h [4].

Statistical analysis

Data were analyzed using SPSS version 25. Means, standard deviations, medians, ranges, and percentages were measured. The correlations between different parameters were done using the Pearson correlation analysis. The *P*-value was considered significant if less than 0.05.

This study was conducted, analyzed, and designed by its authors and required no considerable funding. During the period of this study (between May 2017 and March 2020), all patients with chronic kidney diseases attended the outpatient renal patient clinic and those who fulfilled all inclusion criteria (liver cell failure, chronic chest disease, and diabetes) were included in the study, and at the end of the study time, 100 patients were included.

Results

This prospective cross-sectional study was conducted on one hundred CKD patients: 38.0% males and 62.0% females in group I and 46.0% males and 54.0% females in group II. The mean age was 51.74 ± 13.19 years vs. 56.08 ± 14.79 in group I and II patients consequently. The mean BMI was 27.20 ± 7.83 vs. 29.80 ± 7.98 and the mean neck circumferences were 35.88 ± 4.47 cm vs. 37.34 ± 4.48 cm in the group I and group II patients consequently with no statistically significant differences between both groups. The rest of the demographic data was illustrated in Table 1. All CKD patients presented with sleep-disordered symptoms such as RLM, insomnia, nocturnal arousal, and excessive daytime sleepiness (EDS). RLM was more prevalent in group I than group II patients (40% vs. 16%) with *P*-value = 0.008. Also, insomnia was

Table 1 Demographic data of both groups of chronic kidney disease patients

	Group I CKD patients on dialysis ($n = 50$)	Group II CKD patients not on dialysis ($n = 50$)	*P*-value
Sex			
Male	19 (38.0%)	23 (46.0%)	0.418
Female	31 (62.0%)	27 (54.0%)	
Age			
Mean ± SD	51.74 ± 13.19	56.08 ± 14.79	0.125
Range	22.0–80.0	19.0–90.0	
Smoking			
Non-smoker	45 (90.0%)	37 (74.0%)	
Current smoker	0 (0.0%)	9 (18.0%)	**0.007**
Ex-smoker	5 (10.0%)	4 (8.0%)	
Hypertension	38 (76.0%)	26 (52.0%)	**0.012**
Ischemic heart disease	5 (10.0%)	6 (12.0%)	0.749
CVS	3 (6.0%)	1 (2.0%)	0.617
BMI (body mass index)			
Mean ± SD	27.20 ± 7.83	29.80 ± 7.98	0.104
Range	14.7–48.3	15.9–47.3	
Neck circumference (cm)			
Mean ± SD	35.88 ± 4.47	37.34 ± 4.48	0.106
Range	28.0–49.0	27.0–49.0	

Table 2 Sleep disorder symptoms among both groups of CKD patients

Sleep disorder symptoms	Group I CKD patients on dialysis ($n = 50$)	Group II CKD patients not on dialysis ($n = 50$)	*P*-value
Tiredness and easy fatigability	38 (76.0%)	40 (80.0%)	0.629
Morning headache	26 (52.0%)	19 (38.0%)	0.159
Excessive daytime sleepiness (by Epworth Sleeping Scale)	19 (38.0%)	18 (36.0%)	0.836
Arousal on dyspnea	26 (52.0%)	21 (42.0%)	0.316
Insomnia	20 (40.0%)	19 (38.0%)	**0.003**
Restless leg movement	20 (40.0%)	8 (16.0%)	**0.008**
Observed apnea	6 (12.0%)	6 (12.0%)	1.000

Table 3 Periodic leg movements among both groups of CKD patients

Periodic limb movements	Group I CKD patients on dialysis ($n = 50$)	Group II CKD patients not on dialysis ($n = 50$)	*P*-value
Prevalence	30 (60%)	33 (66%)	0.748
PLM index			
Mean ± SD	29.90 ± 19.19	17.54 ± 13.56	

Table 4 Arousal due to PLM in both groups of CKD patients

Arousal index (due to PLMs)	Group I CKD patients on dialysis ($n = 50$)	Group II CKD patients not on dialysis ($n = 50$)	*P*-value
Mean ± SD	11.22 ± 8.11	12.96 ± 13.74	0.553
Median (range)	7.3 (0.5–47.0)	6.3 (0.6–80.0)	

Table 5 Correlation of PLMs with renal function tests and HGB level among both groups of CKD patients

Renal function tests and HGB level		Group I CKD patients on dialysis ($n = 50$) PLM index	Group II CKD patients not on dialysis ($n = 50$) PLM index
Serum urea	***r*-value**	0.38	0.33
	***P*-value**	**0.04**	**0.030**
Serum creatinine	***r*-value**	0.029	0.098
	***P*-value**	0.842	0.497
GFR	***r*-value**	−0.030	−0.017
	***P*-value**	0.836	0.906
HGB	***r*-value**	−0.251	−0.291
	***P*-value**	**0.037**	**0.010**

Table 6 Correlation of PLMs with BMI in both groups of CKD patients

BMI	Group I CKD patients on dialysis PLM index	Group II CKD patients not on dialysis PLM index
***r*-value**	−0.136	0.092
***P*-value**	0.346	0.524

more prevalent in group I than group II patients (40% vs. 38%) with *P*-value = 0.003. EDS (assessed by ESS) was high in group I and group II (38.0% and 36.0%) with no statistically significant difference (Table 2). The overnight polysomnography revealed a high prevalence of periodic limb movements in both groups of CKD patients (60% in dialysis vs. 66% in non-dialysis patients) with mean PLM indices insignificantly higher in group I than group II (29.90 ± 19.19/h vs. 17.54 ± 13.56/h, *P*-value = 0.748) (Table 3). We detected a high index of nocturnal arousals due to PLM in both groups of CKD patients with a mean arousal index of 11.22 ± 8.11/h vs. 12.96 ± 13.74/h in group I and group II consequently with no significant differences between the two groups (Table 4).

Our study revealed also a significant positive correlation between periodic leg movements and serum urea level (*r*-value = 0.38 and 0.33 and *P*-value = 0.04 and 0.030 in group I and group II consequently). Also, we reported a significant negative correlation between periodic leg movements and hemoglobin level ($r = -0.251$ and −0.291 and *P*-value = 0.037 and 0.010 in group I and group II consequently) (Table 5). There was no statistically significant correlation between PLM index and BMI in both CKD groups (Table 6).

Discussion

Periodic leg movement disorder is defined as periodic episodes of repetitive limb movements during sleep that mainly occurs in the lower limb, including the hips,

knees, and toes, and sometimes affects the upper limb. It may be accompanied by frequent nocturnal awakening, and this sleep disturbance may cause excessive daytime sleepiness [1]. CKD patients are at risk of PLM and common causes are anemia, hypercalcemia, and central and peripheral nervous system disorders [2].

Our study revealed a high prevalence of periodic limb movements in both groups of CKD patients: 60% in dialysis and 66% in non-dialysis patients. The mean PLM indices were 29.90 ± 19.19/h and 17.54 ± 13.56/h in group I and group II patients consequently (*P*-value = 0.748). Our results are consistent with Mohamed Eltawdya et al. who studied sleep disturbances in CKD patients and found that CKD patients had a higher index of PLMs compared with controls (2.0 ± 3.63 vs. 0.35 ± 0.74, *P*-value = 0.048) [5]. Also, Hae et al. investigated the PLM index in thirty patients on maintenance hemodialysis that underwent overnight polysomnography and observed that the median PLMI was 36.9 (range: 0.9 to 207.8), and 70% of patients had PLMs of varying severity [6]. Similarly, Roselyne et al. who studied forty-eight dialysis patients with a 2-day PSG observed PLM disorder in 70.8% of the patients [7].

Our study has reported significant mild positive correlations between PLMs and serum urea levels (with *r* = 0.38 and 0.33 and *P*-value = 0.04 and 0.030) in group I and group II consequently and there was a significant mild negative correlation between PLMs and HGB levels (*r*-value = −0.251 and −0.291 and *P*-value = 0.037 and 0.010) in group I and group II consequently. This was consistent with Haitham et al. who studied the prevalence of sleep disorders in CKD patients in comparison to thirty control participants. All subjects underwent one attended PSG. They reported a negative correlation between the detected PLM and hemoglobin level and creatinine clearance and concluded that treatment of anemia may improve PLM in CKD patients [8]. Also, Benz et al. found that an increase in hematocrit levels induces a significant improvement of PLMs in CKD patients [9]. Similarly, Walker et al. studied sleep complaints in a dialysis unit and found that restless leg movement which is the clinical presentation of PLM was related to serum creatinine and urea levels; hence, it is suggested that the improvement in dialysis efficacy has contributed to the reduction of incidence of RLS [10].

Conclusion

Periodic leg movement disorder is highly prevalent among CKD patients either on dialysis or not, and good management of renal dysfunction and anemia in those patients can help in the management of PLM.

Recommendation

Periodic leg movement disorder is common among CKD patients. It may be accompanied by frequent nocturnal arousals and sleep disturbance. So, its understanding and recognition in CKD patients is a necessity for physicians, and good controlling of anemia and renal impairment is important to decrease the incidence of this sleep disorder.

Abbreviations

BMI: Body mass index; CKD: Chronic kidney disease; EEG: Electroencephalogram; EOG: Electrooculogram; PLM: Periodic limb movement; PSG: Polysomnography.

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Authors' contributions

All authors substantially contributed to the conception, design, analysis, and interpretation of the data and checking and approving the final version of the manuscript and agree to be accountable for its contents.

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Declarations

Ethics approval and consent to participate

The study was approved by the Faculty of Medicine Ethics Committee, Aswan University Hospital (IRB, 150/7/17). In addition, informed written consent was obtained from all participants. The study was conducted by Helsinki standards as revised in 2013.

Competing interests

The authors declare that they have no competing interests.

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