ORIGINAL ARTICLES

Sonographic assessment of thyroid gland in patients with chronic kidney disease undergoing hemodialysis

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ABSTRACT

Background: Thyroid gland morphology and disorders were affected with chronic kidney diseases (CKD). The study aims to assess thyroid gland disorders and morphology in patients with CKD on regular hemodialysis.
Materials and methods: A cross-sectional study included 71 participants divided into two groups. The study group included 51 patients with known chronic kidney disease on hemodialysis and healthy group included 20 participants. The exclusion criteria were thyroid disorders. The thyroid gland was scanned with ultrasound using a 7 MHz probe.
Results: The thyroid is enlarged in 21.57% of patients and heterogeneous echotexture in 31.4%. The prevalence of thyroid nodules and cysts were 9.8% and 7.8% respectively. A positive linear correlation existed between duration of hemodialysis and thyroid volume. Thyroid volume and echotexture were significantly increased with duration of hemodialysis (p = .001 and .00 respectively). Thyroid nodules and cysts were not significantly correlated with duration of hemodialysis (p = .06 and .28 respectively).
Conclusions: In conclusion, enlargement of thyroid gland and heterogeneity of thyroid tissue were the most common morphological changes in patients with chronic renal failure undergoing hemodialysis. The prevalence increased with longer duration of hemodialysis. Periodic ultrasound assessment of thyroid volume and texture are recommended in hemodialyzed patients to avoid complications.

Key Words: Sonographic, Assessment, Thyroid, Chronic, Kidney, Hemodialysis

1. INTRODUCTION

The thyroid gland is an important organ since it regulates metabolism and controls several vital functions.[1] There are many diseases affect the size of the thyroid gland. The chronic renal failure (CRF) and hemodialysis (HD) have a significant effect on several hormonal and metabolic disorders that cause morphological changes of the gland.[2] Chronic kidney disease (CKD) is responsible for goiter and nodules since it causes reduced glomerular filtration.[3] End stage renal failuire is a major health problem in Sub Saharian Africa. There were limited studies and data about causes of ESRF in the Sudan.[4] A previous study conducted in Sudan found that the leading cause of ESRD was glomerular disease, hypertension and obstruction.[5] In Sudan, June 2009, there were 2,858 patients on HD, 122 patients on continuous ambulatory peritoneal dialysis, and 1,168 kidney transplant recipients.[6] However, to our knowledge, rare studies conducted to demonstrate the effect of CKD and HD on the thyroid gland in Khartoum State.

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Duration of hemodialysis has an impact on the thyroid gland. There was increased incidence of nodules and goiter in patients underwent long duration of HD, and they are subject to rapid loss of renal function.[7] Most of the previous studies concluded that renal diseases have a significant impact on thyroid function and morphology. Therefore, this study highlighted the importance of sonographic assessment of thyroid gland in hemodialized patients.

Ultrasound (US) is an ideal imaging modality for detection and assessment of thyroid diseases and volume. It is easy to perform, widely available and does not involve ionizing radiation. In this study, we used high-frequency transducers since they have significantly improved spatial and contrast resolution in evaluating the thyroid gland. The ultrasound is very sensitive in detecting thyroid nodules. These nodules are classified as adenomas, carcinomas and hyperplastic lesions.[8,9] The sonographic appearance of benign thyroid nodules was isoechogenecity and the sensitivity of US was 56.6%, and specificity was 88.1%.[10]

The aim of this study is to assess morphological disorders and echotexture of the thyroid gland in patients with CKD who underwent regular HD. And to assess whether there is an association between thyroid disorders and duration of HD. Sonographic evaluation of thyroid helps to prevent thyroid abnormalities and complications as a result of long term hemodialysis. The importance of this study is to provide Clinicians and Nephrologists in dialysis centres of Khartoum with informative data on impact of HD on thyroid gland that help in optimal management of the patient. However, there were few published data in Khartoum State regarding the ultrasound evaluation of thyroid in hemodialized patients.

2. Materials and methods

2.1 Participants

This was a cross-sectional study conducted in Khartoum North Centre for renal hemodialysis and Professor Abd Alsamad Salih Centre for ultrasound training-AAU.

The study was conducted in the period from March 2016 to July 2016. The participants were 71 patients (21 males and 30 female) divided into two groups. The case study group composed of 51 stable patients with confirmed CKD on regular hemodialysis program. They were referred to ultrasound department for examination of thyroid glands. The control group included 20 healthy participants. Exclusion criteria were previous thyroid disorders and systematic diseases. Informed consent was taken from the participants. Simple, convenient systematic sampling was used to select the participants. The study was approved by the Institutional Ethical Committee.

2.2 The sonographic procedure

The thyroid gland was scanned using a 7.5 MHz probe with linear transducer on the ultrasound machines (GE logiq Book X8 and Toshiba-model Xario 200). The patients were investigated in supine position. The head and neck were slightly raised; a pillow was put under the shoulders. The thyroid volume was determined by three consecutive measurements (length (L), depth(D) and width (W), which were taken for each thyroid lobe, then the thyroid volume for each lobe were calculated with the formula: $V = L \times W \times D \times n/6$. In this formula, D is the depth, L is length, W is width and n/6 represent the correction factor measuring 0.479.[11] The final thyroid volume was calculated as a sum of lobe volumes regardless of presence or absence of nodules. Then the thyroid echotexture was assessed and classified as homogeneous and heterogeneous texture. The goiter is determined clinically and sonographically. The limits of normal thyroid volume are 10-15 ml for females and 12-18 ml for males.[12] The nodules were defined as confined distinct region of thyroid parenchyma located within thyroid tissue. High frequency US transducers detect thyroid lesions as small as 2 to 3 mm. However, nodules were differentiated from cysts since the cysts appear as small as 2 mm and solid nodules as small as 3 mm.[13,14]

2.3 Statistical analysis

The data were analyzed using SPSS software statistical program version 16. Data were statistically analysed using descriptive statistics (frequency and percentage) and Pearson correlation test. Linear regression was used to predict the increase in volume of thyroid gland and lobes in duration of dialysis. P value $< .05$ was considered to be statistically significant.

3. Results

The hemodialyzed patients with CKD were 59% female and 41% male respectively (see Figure 1). The mean age was 46.27 ± 14.46 years. The age was categorized into five groups. The patients with CKD and on hemodialysis were most commonly distributed in the age groups of 43-55 and 30-42 years old and the incidence was 31.4% and 29.5% respectively (see Figure 2). The sonographic findings revealed that goiter was the main finding (21.57%), nodules (9.7%) and cysts (7.8%). The sonographic assessment of thyroid echotexture showed that 31.4% was heterogeneous and 68.6% was homogeneous texture (see Table 1). Mean thyroid volume was significantly higher in HD group than control group (11.10 cm vs. 9.47 cm, $p = .001$) as depicted in Figure 3. It was observed that the right lobe is significantly more enlarged in HD group than controls ($p = .040$) whereas the left lobe is not significantly different compared to the

controls (p = .082), as shown in Table 2. At the same time, the volume of the right lobe is significantly higher in HD group than control group (5.88 cm vs. 4.93 cm, p = .04). The measurements of thyroid gland are shown in Figure 5.

The duration of analysis is significantly correlated with thyroid echotexture and thyroid volume (p = .00 and .001 respectively) as shown in Table 3. Thus, prolonged duration of CKD and hemodialysis made the thyroid enlarged and heterogeneous from an echotexture standpoint. It was found that thyroid nodules and cysts were not statistically correlated with duration of HD (p = .06 and .28). Thus, the prevalence of nodules and cysts were attributed to the impairment of the kidneys rather than duration of the hemodialysis. In Table 4, the thyroid volume was compared with previous studies to identify the influence of duration of HD on thyroid volume. The volume in our study was approximately similar to what was previously reported by Sarvghadi et al; 12.10 cm vs. 11.10 cm.[15] There was a positive linear correlation between duration of dialysis and size of thyroid gland, right lobe and left lobe (r = 0.35, p = .013, r = .32, p = .022, r = .36, p = .011 respectively). The linear correlation was demonstrated in Figure 4. Regression equations were formulated to predict the increase in volume (see Table 5). The regression equation of thyroid volume V = 8.711 + 0.058D indicates that the total thyroid volume increase 8.769 mm/month while the right lobe increased 4.665 mm/month and the left lobe increased 4.094 mm/month (see Table 5).

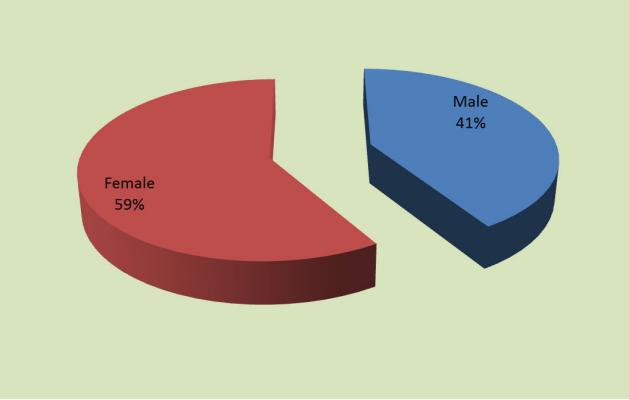

Figure 1. Gender distribution of the patients with CKD on hemodialysis

Table 1. Sonographic findings of thyroid gland in patients with CRF on hemodialysis

Findings	Frequency	Percent
Cysts	4	7.8%
Nodules	5	9.8%
Goitre	11	21.57%
Heterogeneous echotexture	16	31.4%
Homogeneous echotexture	35	68.6%

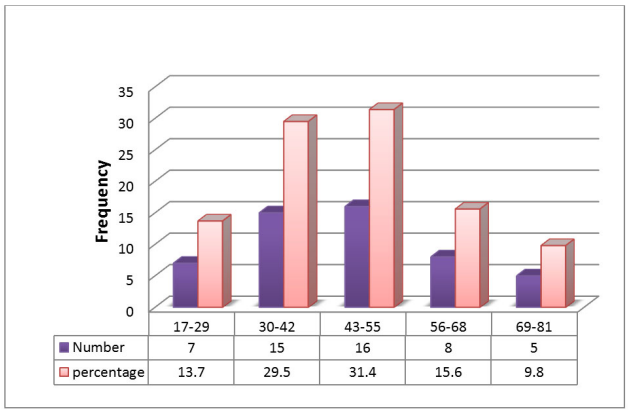

Figure 2. Distribution of age groups (years) of the patients with CKD on hemodialysis

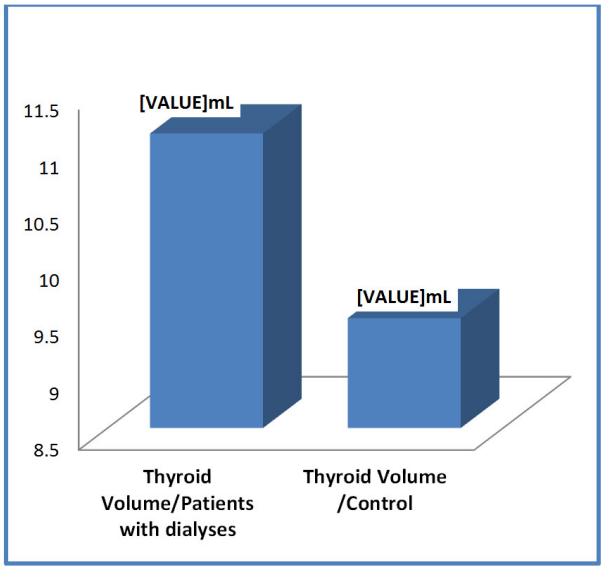

Figure 3. Comparison of thyroid volume (ml) of patients with hemodialysis and control group

Table 2. Comparison between hemodialysis group and controls

Variable	Hemodialysis group (mean ± SD) cm	Control group (mean ± SD) cm	p
Right lobe volume	5.88 ± 3.32	4.93 ± 1.38	.040
Left lobe volume	5.23 ± 2.79	4.54 ± 1.32	.082
Thyroid volume	11.10 ± 5.91	9.47 ± 2.61	.001

Table 3. Correlation of sonographic findings of thyroid with duration of hemodialysis

Sonographic findings	Duration of hemodialysis	
	Correlation (r)	p
Nodules	-.27	.06
Cysts	-.16	.28
Thyroid echotexture	-.54	.00
Thyroid volume	.44	.001

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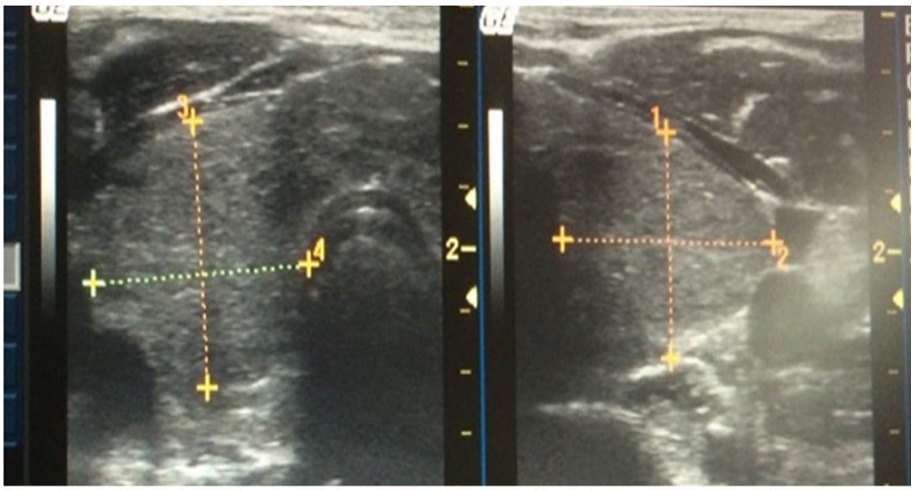

Figure 4. Sonographic measurements of thyroid lobes

Table 4. Comparison of thyroid volume and dialysis duration in previous studies and the current study

Author/year	Sample size	Dialysis duration (month)	Thyroid volume (ml)	Control thyroid volume (ml)
Mete et al. 2016	42	39.7 ± 21.8	14.91 ± 5.30	12.2 ± 26.21
Sarvghadi F, et al. 2008	35	18.2 ± 8.1	12.1 ± 6.0	-
Selma Jusufovic, et al. 2011	40	60.32 ± 36.18	18.88 ± 3.20	10.71 ± 4.32
Ihab A. et al. 2016	40	6.38 ± 3.14	9.60 ± 2.44	8.30 ± 1.18
The current study	51	41.45 ± 35.6	11.10 ± 5.9	9.47 ± 2.6

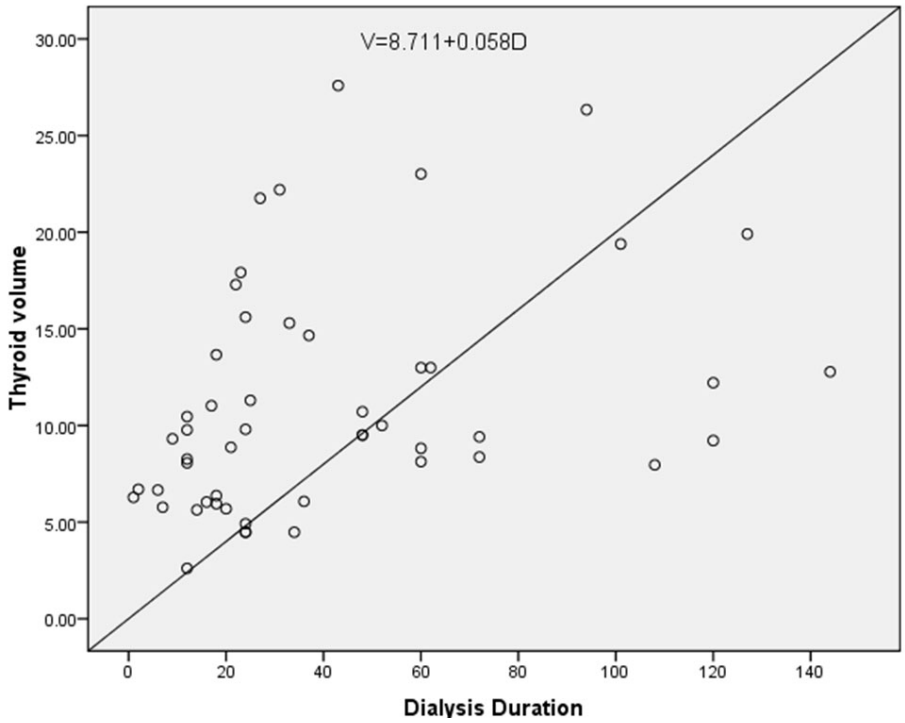

Figure 5. The correlation between thyroid volume (mm) and dialysis duration (months)

Table 5. The correlation of hemodialysis duration with size of thyroid lobes

Parameters	Correlation with duration (*r*)	Significance (*p*-value)	Regression equations
Right lobe	0.32	.022	VR = 4.635 + 0.030D
Left lobe	0.36	.011	VL = 4.076 + 0.028D
Total size of thyroid	0.35	.013	V = 8.711 + 0.058D

Note. D = duration of hemodialysis, VR: volume of right lobe, VL: volume of left lobe

4. Discussion

The relation between CKD and thyroid disorders was demonstrated in various studies and revealed that CKD affects metabolism and thyroid hormones which in turn influence the morphology of the thyroid. It was observed these hormones increased after HD.[1] The present study was conducted to assess thyroid disorders in patients suffering from CRF undergoing HD. In the present study, the incidence of thyroid disorders was common in female more than male. This result agreed with Ana et al. who reported the prevalence of thyroid disorders was higher in female than male.[16]

The current study revealed that the incidence of thyroid goiter was 21.57% in patients with CKD, which is approximately higher than previous studies. This finding agreed with Mohamed et al., who reported: "increased prevalence of thyroid goiter (0%-9%) in patients with CKD".[1] Our finding also agreed with Selma et al., who reported that diffuse goiter is frequently common in HD (p = .0001). They found the mean thyroid volume was significantly higher in HD group (18.88 $\pm$ 3.20 ml), comparing to the normal group.[17] In the present study, the average value of thyroid volume is higher in HD group (11.1 $\pm$ 5.9 ml), comparing to control group. Interestingly, we observed the right lobe is significantly enlarged more than the left lobe in the study group. The etiology of goiter is attributed to impairment of clearance of the inorganic acid causing hypertrophic effect.[18]

The current study revealed that thyroid nodules and cysts were the second findings in patients with CRF undergoing HD. This result agreed with Toru et al., who analyzed thyroid nodules in hemodialyzed patients using ultrasonography. He reported that the prevalence of simple cyst and nodules was 30% and 11.9% respectively.[19] The current study revealed there was no significant correlation between thyroid nodules and cysts in HD patients.

The hemodialysis has been established to cause thyroid abnormalities in function and morphology in patients with ESRD. It was reported that the prevalence of goiter was significantly increased in patients with ESRD.[20] In this study, it was observed that duration of hemodialysis has an impact on thyroid volume. There was a linear positive correlation of thyroid volumes and lobes with duration of dialysis. This indicates that thyroid goiter was significantly correlated with duration of hemodialysis. This finding is in agreement with Kaptein EM who reported a higher incidence of diffuse goiter is increased in HD patients, although some studies found no relationship between duration of analysis and morphological changes in the thyroid gland.[21,22] Selma and Emir reported that thyroid volume were increased in HD patients and diffuse goiter is significantly observed more frequent in HD compared to control group (p = .001).[23] These findings supported that the period of HD has a significant impact on thyroid volume and echotexture (p = .001, .00 respectively). Therefore, the length of duration of HD made the thyroid tissue texture heterogeneously hyperechoic and hypertrophic. The thyroid enlargement is attributed to impairment of renal functions which disturb morphology and physiology of thyroid gland.[24]

Limitation of the study

The study faced limitations. Firstly, the nature of the cross-sectional design of the survey depended on particular population and the study lacking thyroid function tests. Secondly, the sample size is not large enough, so the relationship between the thyroid gland and CKD should be further investigated in a prospective study with larger number of patients. However, to our knowledge, this might be useful survey maintained among Sudanese patients with CKD on HD regarding morphological changes of the thyroid gland.

5. Conclusion

The study concluded that thyroid morphological disorders were more common in patients with CRF who were undergoing HD. Thyroid goiter was the primary disorder in these patients. The CRF and HD have an impact on thyroid echotexture and morphology. HD causes heterogeneous echotexture of the thyroid tissue and is increased with longer duration.

Conflicts of Interest Disclosure

The authors declared there was no conflict of interest regarding the study.

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