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Original Article

Ultrasonographic Assessment of Renal Dimensions in Diabetic Patients: A Cross-Sectional Study in Libya

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Abstract

Background: Diabetes mellitus (DM) is a major global health concern and one of the leading causes of renal structural and functional alterations. Ultrasonography provides a non-invasive and reliable tool for evaluating renal morphology and detecting early diabetic nephropathy. This study aimed to determine renal dimensions in diabetic patients and to analyze their correlation with age, gender, and diabetes type. **Material and Methods:** A prospective cross-sectional study was conducted at Az Zawiyah Kidney Hospital and Zawia Medical Center from June to September 2023. Sixty-five adult diabetic patients (20–75 years) underwent renal ultrasound using Philips Clearvue 850 and Aloka Prosound 2 scanners. Renal length, width, and cortical thickness were measured to estimate kidney size. Statistical analyses were performed using SPSS v27, applying descriptive statistics, t-tests, and ANOVA. **Results:** The mean right and left renal sizes were 40.06 ± 26.82 cm³ and 51.81 ± 38.47 cm³, respectively. Male patients showed slightly larger renal dimensions than females, though the differences were statistically insignificant ($p > 0.05$). In type 1 diabetes, right kidney size was larger, whereas in type 2 diabetes, the left kidney was comparatively larger. Renal dimensions demonstrated mild correlations with age and gender, but not with diabetes type. **Conclusion:** Diabetic patients generally exhibit smaller renal dimensions compared to normal values, indicating progressive parenchymal atrophy associated with diabetes duration. Ultrasound remains an effective, safe, and affordable diagnostic tool for detecting early renal alterations in diabetic patients. Further large-scale studies are recommended across Libya to validate these findings.

Keywords: Diabetes mellitus, ultrasonography, renal size, renal morphology, diabetic nephropathy

Introduction

Diabetes mellitus (DM) is a chronic metabolic disorder characterized by hyperglycemia due to defects in insulin secretion, insulin action, or both [1]. It represents a significant global health burden, affecting millions worldwide and leading to severe systemic complications, particularly in the kidneys. Diabetic nephropathy (DN) is among the most common microvascular complications of diabetes and a major cause of end-stage renal disease (ESRD) [2]. Early identification of renal morphological changes is crucial for timely intervention and management. The kidneys are vital organs responsible for filtration, reabsorption, and excretion processes that maintain homeostasis [3]. Alterations in renal morphology—such as changes in renal size, cortical thickness, or volume—reflect functional impairment. In diabetic patients, these changes can progress silently over years, often before clinical or biochemical evidence of renal dysfunction appears.

Ultrasonography is a widely accessible, non-invasive, and cost-effective imaging technique for assessing renal size and structure [4]. It provides valuable information regarding renal length, width, cortical thickness, and overall kidney morphology, making it a useful tool for detecting early diabetic nephropathy, particularly in resource-limited settings such as Libya.

Previous studies have shown variable effects of diabetes on renal morphology. Early diabetes may cause renal hypertrophy due to hyperfiltration, while advanced disease may lead to cortical thinning and atrophy [5–7]. Limited data exist regarding renal size patterns among Libyan diabetic patients. This study aimed to evaluate renal dimensions in diabetic patients in Az Zawiyah and Zawia Medical Centers, Libya, using ultrasonography, and to explore associations between renal size and demographic variables such as age, gender, and diabetes type.

Materials and Methods

1.Study Design and Setting

A prospective cross-sectional study was conducted at the Radiology Departments of Az Zawiyah Kidney Hospital and Zawia Medical Center, Libya, between June and September 2023. The study aimed to determine renal dimensions in diabetic patients using ultrasonography and to assess their correlation with demographic and clinical variables.

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2. Study Population and Sample Size

A total of 65 adult diabetic patients (20 males and 45 females), aged between 20 and 75 years, were enrolled. Both type 1 and type 2 diabetic patients undergoing routine ultrasound examinations were included. Patients with known renal disease unrelated to diabetes, congenital anomalies, or previous kidney surgery were excluded.

3 Ultrasound Equipment and Measurement Protocol

Ultrasonographic examinations were performed using Philips ClearVue 850 and Aloka Prosound 2 scanners equipped with convex probes operating at frequencies between 3.5–5 MHz. Participants were instructed to fast for at least six hours prior to examination to minimize bowel gas interference. Each patient was examined in both supine and lateral decubitus positions.

Measurements included:

- **Renal Length (RL):** Maximum pole-to-pole distance in the longitudinal plane
- **Renal Width (RW):** Maximum transverse diameter of the kidney
- **Cortical Thickness (CTh):** Distance from the renal capsule to the base of the medullary pyramid

Renal volume was estimated using the ellipsoid formula:

Renal Size (cm³) = RL × RW × CTh

2.4 Data Collection and Statistical Analysis

Patient demographic data (age, sex, and diabetes type) and ultrasound measurements were recorded. Data were analyzed using SPSS version 27 (IBM Corp., USA). Descriptive statistics were expressed as mean ± standard deviation (SD). Independent samples t-tests and one-way ANOVA were used to compare renal dimensions across gender and diabetes type. A p-value < 0.05 was considered statistically significant.

Results

1.Demographic Characteristics

Sixty-five diabetic patients were examined, comprising 20 males (30.8%) and 45 females (69.2%), aged between 20 and 75 years. Of these, 36 patients (55.4%) had type 1 diabetes mellitus (T1DM) and 29 patients (44.6%) had type 2 diabetes mellitus (T2DM).

Table 1. Descriptive Statistics of Renal Dimensions (n = 65)

Variable	Minimum	Maximum	Mean ± SD
Right renal length (cm)	6.90	12.30	9.66 ± 1.30
Left renal length (cm)	8.00	12.80	10.03 ± 1.14
Right renal size (cm³)	4.20	135.50	40.06 ± 26.82
Left renal size (cm³)	12.80	223.70	51.81 ± 38.47

Table 2. Renal Dimensions by Gender

Variable	Male (n=20) Mean ± SD	Female (n=45) Mean ± SD	p-value
Right renal size (cm³)	40.43 ± 26.59	39.85 ± 27.22	>0.05
Left renal size (cm³)	52.17 ± 26.17	51.65 ± 43.09	>0.05

Table 3. Renal Dimensions by Diabetes Type

Variable	T1DM (n=36) Mean ± SD	T2DM (n=29) Mean ± SD	p-value
Right renal size (cm³)	42.64 ± 30.47	36.85 ± 21.57	>0.05
Left renal size (cm³)	49.22 ± 30.46	55.02 ± 46.94	>0.05

Key Findings

- The left kidney was consistently larger than the right across all groups.
- Male participants exhibited marginally larger kidneys than females.
- No significant difference was found between type 1 and type 2 diabetes in overall renal size.
- A weak positive correlation was observed between renal dimensions and age.

Discussion

This study investigated renal dimensions in Libyan diabetic patients using ultrasonography, examining correlations between kidney size, gender, age, and diabetes type. Results showed a general reduction in renal dimensions compared to normal reference values, with no

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statistically significant differences between genders or diabetes types.

Left kidneys were consistently larger than right kidneys, in agreement with anatomical and sonographic studies [8]. Male patients had slightly larger kidneys, consistent with previous studies linking renal volume to body surface area and height [9,10].

Reduced renal size in diabetic patients may reflect cumulative effects of diabetic nephropathy and microvascular damage on renal parenchyma [11,12]. Minor differences between T1DM and T2DM kidneys may indicate variations in disease progression and compensatory mechanisms. Aging may also contribute to renal morphological alterations independent of diabetes [13].

Ultrasonography remains an effective, non-invasive, cost-effective tool for monitoring diabetic nephropathy, particularly in resource-limited settings.

Conclusion

Diabetic patients exhibit notable alterations in renal dimensions. Kidneys were generally smaller than normal reference ranges, suggesting progressive parenchymal atrophy related to diabetes duration and severity.

Differences between gender and diabetes type were not significant, though males generally had slightly larger kidneys. The left kidney was consistently larger than the right. Ultrasound is valuable for early detection of renal changes.

Limitations

This study has several limitations that should be considered when interpreting the results. First, the sample size was relatively small (n = 65), which may limit the generalizability of the findings to the broader diabetic population in Libya. Second, the study design was cross-sectional, preventing assessment of causal relationships or longitudinal changes in renal dimensions.

Additionally, factors such as duration of diabetes, glycemic control (e.g., HbA1c levels), body mass index, and comorbidities were not extensively analyzed, which may influence renal morphology. Inter-observer variability in ultrasound measurements may also have affected the accuracy of the results, despite the use of standardized protocols.

Finally, the study was conducted in two centers only, which may not fully represent regional variations across the country.

Ethical Approval

This study was conducted in accordance with the ethical standards of the institutional and national research committees and with the 1964 Helsinki Declaration and its later amendments. Ethical approval was obtained from the relevant Institutional Review Board (IRB) of Zawia Kidney Hospital and Zawia Medical Center, Libya.

All participants were informed about the purpose of the study. Patient confidentiality and data privacy were strictly maintained throughout the study.

Conflict of interest:

The authors declare that there is no conflict of interest regarding the publication of this paper.

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