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Impact of Cigarette Smoking on Renal Morphology Assessed by Ultrasound: A Cross-Sectional Study

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Abstract | **Original Research Article**

Background: Cigarette smoking is a major global health concern and a recognized risk factor for chronic kidney disease. Structural renal alterations may occur before the onset of measurable functional impairment and can be detected using ultrasound. ***Objective:*** This study aimed to assess the impact of cigarette smoking on renal morphology using ultrasound and to correlate imaging findings with renal function parameters. ***Methods:*** A prospective cross-sectional study was conducted on 150 adult participants, including 60 smokers and 90 non-smokers. Renal ultrasound examinations were performed to measure kidney length, width, parenchymal thickness, and echogenicity. Serum creatinine levels and glomerular filtration rate (GFR) were evaluated. Statistical analysis was performed using SPSS, and significance was set at $p < 0.05$. ***Results:*** Smokers demonstrated significantly reduced renal length and parenchymal thickness compared with non-smokers. Renal echogenicity grades were significantly higher among smokers. Additionally, smokers showed higher serum creatinine levels and lower GFR values. Increasing pack-years of smoking was associated with progressive deterioration of renal ultrasound parameters. ***Conclusion:*** Cigarette smoking has a significant adverse effect on renal morphology and function. Renal ultrasound is a valuable, non-invasive modality for early detection of smoking-related renal changes.

Keywords: Cigarette smoking, Renal ultrasound, Kidney morphology, Echogenicity, Glomerular filtration rate.

1. INTRODUCTION

Cigarette smoking remains one of the leading preventable causes of morbidity and mortality worldwide. In addition to its well-known effects on the cardiovascular and respiratory systems, smoking has been increasingly recognized as an independent risk factor for chronic kidney disease (CKD). Several pathophysiological mechanisms, including endothelial dysfunction, oxidative stress, inflammation, and microvascular injury, have been implicated in smoking-induced renal damage.

Renal structural changes often precede functional impairment. Early identification of these changes may allow timely intervention and prevention of disease progression. Ultrasound is a widely available, cost-effective, and radiation-free imaging modality commonly used for renal assessment. It provides valuable information regarding kidney size, parenchymal thickness, and echogenicity, which are important indicators of renal health.

Despite existing evidence linking smoking to renal dysfunction, limited studies have focused on the relationship between smoking burden, expressed as pack-years, and detailed renal morphological changes assessed by ultrasound. This study aims to evaluate the effect of cigarette smoking on renal morphology using ultrasound and to correlate these findings with renal function parameters.

2. MATERIALS AND METHODS

2.1 Study Design and Population

A prospective cross-sectional study was conducted between June 2023 and September 2025. The study included 150 adult participants residing in Saudi Arabia, comprising both smokers and non-smokers.

2.2 Inclusion and Exclusion Criteria

Adult participants aged 21–82 years were included. Individuals with known renal disease, chronic systemic illnesses, congenital renal anomalies, or abnormal renal anatomy were excluded from the study.

2.3 Data Collection

Demographic data, smoking status, duration of smoking, and pack-years were collected using a structured data sheet.

2.4 Ultrasound Examination

Renal ultrasound examinations were performed using a curved linear array transducer (3.5–5 MHz). Measurements included bilateral kidney length, width, parenchymal thickness, and assessment of renal echogenicity graded from 0 to 3.

2.5 Laboratory Assessment

Serum creatinine levels and glomerular filtration rate (GFR) were measured for all participants.

2.6 Statistical Analysis

Data were analyzed using SPSS software. Independent t-tests and ANOVA were used to compare groups. Effect size was calculated using Eta squared, and statistical significance was set at $p < 0.05$.

2.7 Ethical Considerations

The study was conducted in accordance with ethical standards. Written informed consent was obtained from all participants, and confidentiality of personal data was ensured.

3. RESULTS

The study population consisted of 150 participants, including 113 males (75.3%) and 37 females (24.7%). Smokers represented 40% of the study population.

Smokers demonstrated significantly reduced renal length and parenchymal thickness compared with non-smokers ($p < 0.05$). Renal echogenicity grades were significantly higher among smokers, indicating increased parenchymal damage. Additionally, smokers exhibited significantly higher serum creatinine levels and lower GFR values compared to non-smokers.

A dose-dependent relationship was observed between pack-years of smoking and deterioration in renal morphological parameters. Participants with higher smoking exposure showed progressive reduction in kidney dimensions and parenchymal thickness.

4. DISCUSSION

This study demonstrates a significant association between cigarette smoking and adverse renal morphological and functional changes. Reduced renal length and parenchymal thickness observed among smokers may reflect chronic ischemic injury and interstitial fibrosis. Increased renal echogenicity further supports the presence of progressive parenchymal damage.

The findings of this study are consistent with previous research reporting smoking-related renal shrinkage and functional impairment. Notably, this study identified a clear dose-dependent relationship between pack-years of smoking and renal damage, emphasizing the cumulative effect of smoking exposure.

The integration of ultrasound findings with laboratory parameters strengthens the clinical relevance of this study. Ultrasound may serve as a valuable screening tool for early detection of renal changes in chronic smokers, allowing timely intervention and smoking cessation.

5. CONCLUSION

Cigarette smoking has a significant negative impact on renal morphology and function. Renal ultrasound is an effective, non-invasive method for early detection of smoking-related renal changes and may help identify individuals at risk of chronic kidney disease.

6. Recommendations

Routine renal ultrasound examination combined with laboratory assessment is recommended for chronic smokers. Smoking cessation programs should emphasize the risk of renal damage. Future longitudinal studies are recommended to assess disease progression over time.

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