

Histopathological Evaluation of DMBA-Induced Renal Changes in Female Mice

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Abstract

Background: 7,12-Dimethylbenz[a]anthracene (DMBA) is a polycyclic aromatic hydrocarbon known for its carcinogenic activity and toxic effects on several organs. This study examined the histopathological changes associated with DMBA exposure in the kidneys of female mice. Renal sections were assessed microscopically for alterations in the architecture of the renal corpuscles, glomeruli, tubules, and associated blood vessels. Control sections retained much of their normal organization, with clearly identifiable glomeruli and renal tubules. Sections from DMBA-exposed mice, however, showed several abnormalities, most of which affected the tubular epithelium. Cytoplasmic vacuolation was the most conspicuous feature together with change in tubular morphology and the appearance of tubular lumina. Focal vascular changes consistent with congestion were also presented in some fields. Despite these abnormalities, the overall outlines of the glomeruli could still be identified. findings associate DMBA exposure with renal tissue injury and that tubular epithelial cells were the principal structures affected. They provide histological evidence of possible nephrotoxicity following DMBA exposure. Further work incorporating biochemical measurements, oxidative stress markers, and molecular analyses is needed to explain the mechanisms responsible for these changes.

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Keywords: 7, 12-Dimethylbenz[a]anthracene (DMBA), Kidney, Renal histopathology, Tubular vacuolation, Nephrotoxicity, Female mice

1. Introduction

The kidneys maintain internal homeostasis by regulating fluid and electrolyte balance, removing metabolic waste, and excreting foreign substances and toxic compounds *(*Suhail *et al.*, 2011) [5]. renal tissue is an important focus of toxicological research Because circulating chemicals and their metabolites continue to pass through the kidneys, (Yildirim *et al.*, 2018) [7].

7,12-Dimethylbenz[a]anthracene (DMBA), a polycyclic aromatic hydrocarbon, is commonly used to study chemical carcinogenesis (Zeweil *et al.*, 2024) [6]. Its metabolic activation can produce reactive metabolites and reactive oxygen species (ROS). Interactions between these products and cellular components may promote oxidative stress and tissue damage (Lakshmi and Subramanian, 2014) [10].

Experimental evidence illustrate that DMBA exposure disrupt the renal architecture,particularly the tubular structures. Reported changes include degeneration and cytoplasmic vacuolation of tubular epithelial cells as well as abnormalities in glomerular and vascular structures (Ozturk *et al.*, 2006) [1].

Epithelial vacuolation, tubular abnormalities,and glomerular changes have also been described in DMBA -exposed mice. These observations reveal that renal tissue can be susceptible to the toxic effects of this compound *(Mumtaz et al., 2024)* [2].

histopathological assessment can help characterize renal responses to chemical exposure given the kidneys' physiological functions and their contact with circulating toxic metabolites (Telussa *et al.*, 2022) [8].

This study have examined renal histopathological changes in female mice exposed to DMBA using routine hematoxylin and eosin (H &E) staining.

2. Materials and Methods

2.1. Experimental Animals

The study included twenty female laboratory mice aged 6 –7 weeks and weighing approximately 20 –30 g. the samlple were housed under standard laboratory conditions and had unrestricted access to food and drinking water throughout the study experiment.

2.2. Experimental Design and Treatment

Two experimental groups were formed with ten animals in each. The study population comprised 20 female Wistar albino mice aged 6 –7 weeks, with body weights of approximately 20 –30 g.

Animals in the control group received no treatment. Those in the experimental group received 7,12 -dimethylbenz[a]anthracene (DMBA) at 20 mg /kg body weight.

DMBA was prepared in sesame oil and delivered orally through a stomach tube by gastric gavage. Administration took place once a week for four consecutive weeks.

2.3. Tissue Collection and Histological Processing

Kidney specimens were obtained at the end of the experiment. After fixation in formalin,the tissues underwent routine processing through dehydration, clearing and paraffin embedding.

A microtome was used to cut the tissue sections which were then stained with hematoxylin and eosin (H&E) according to standard histological method (Suvarna *et al*., 2019) [4].

2.4. Histopathological Examination

A light microscope was used to examine the stained section s at several magnifications.

Assessment covered the overall renal architectur including the glomeruli and tubules. Particular attention was given to tubular epithelial degeneration, cytoplasmic vacuolation, vascular congestion, a nd inflammatory changes.

3. Results

3.1. Histopathological Results

3.1.1. Control Group

Renal section s from control animals largely retained their normal histological organization. The cortex contained regularly distributed renal corpuscles, with identifiable glomeruli enclosed by Bowman's c apsules. Proximal and distal convoluted tubules showed relatively intact epithelial organization and clearly discernible lumina. Blood vessels was visible in the intervening interstitial tissue. Across the examined sections, the renal architecture was generally preserved with no conspicuous, widespread pathological changes.

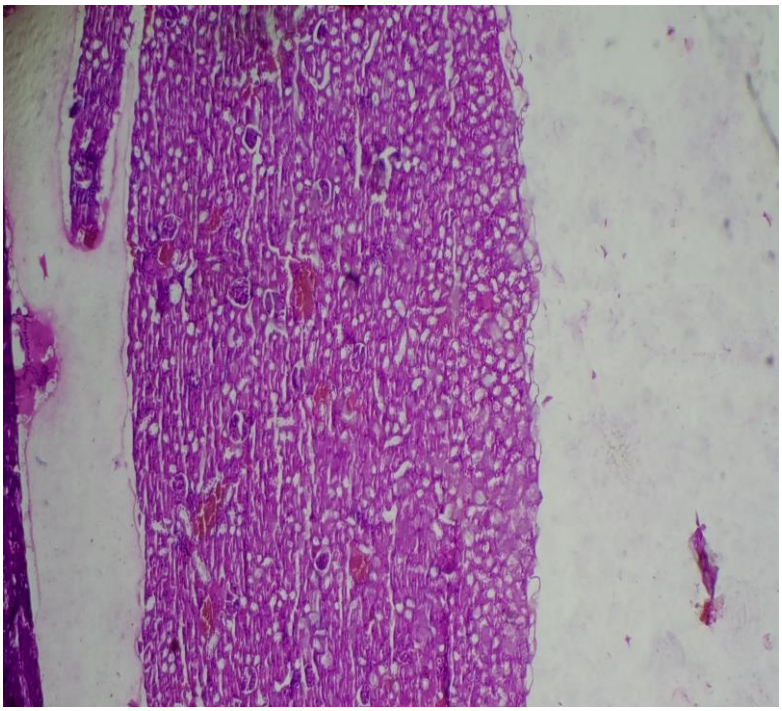


Fig 1: Low -power photomicrograph of a normal mouse kidney, showing renal corpuscles (G), renal tubules (RT), and blood vessels (BV) within relatively preserved tissue architecture e. H &E staining, ×4.

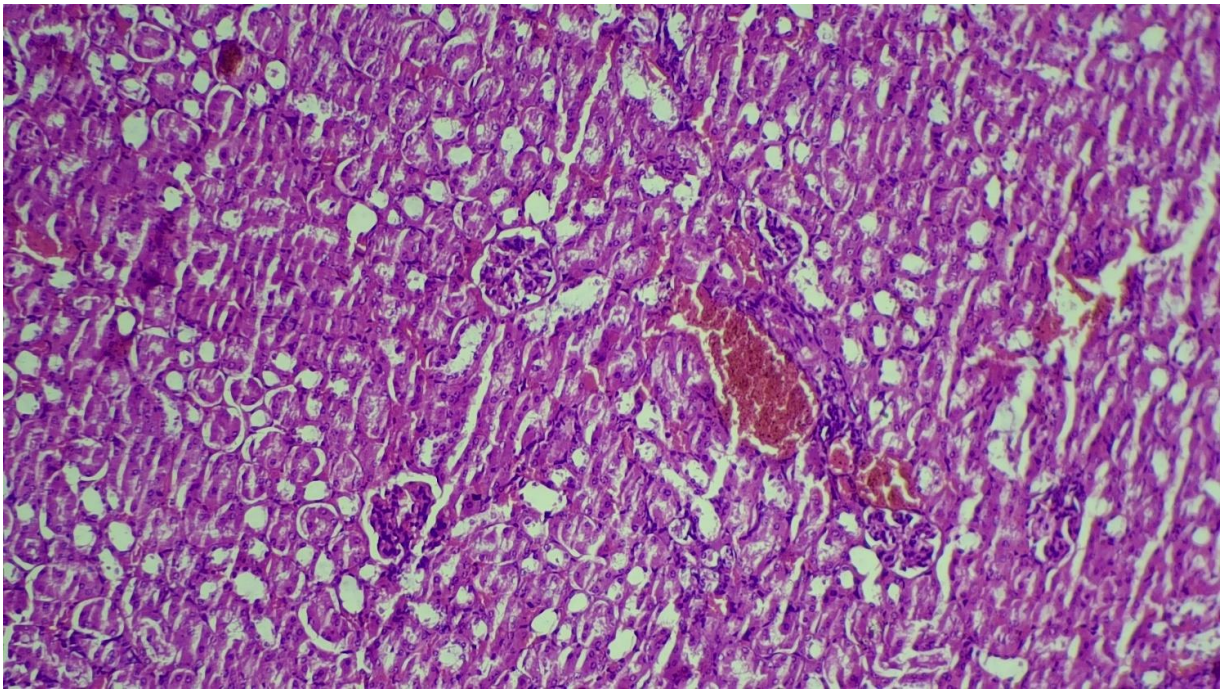


Fig 2: Normal mouse kidney with identifiable glomeruli (G) and surrounding renal tubule (RT) demonstrating preserved cortical organization. H&E staining, ×10.

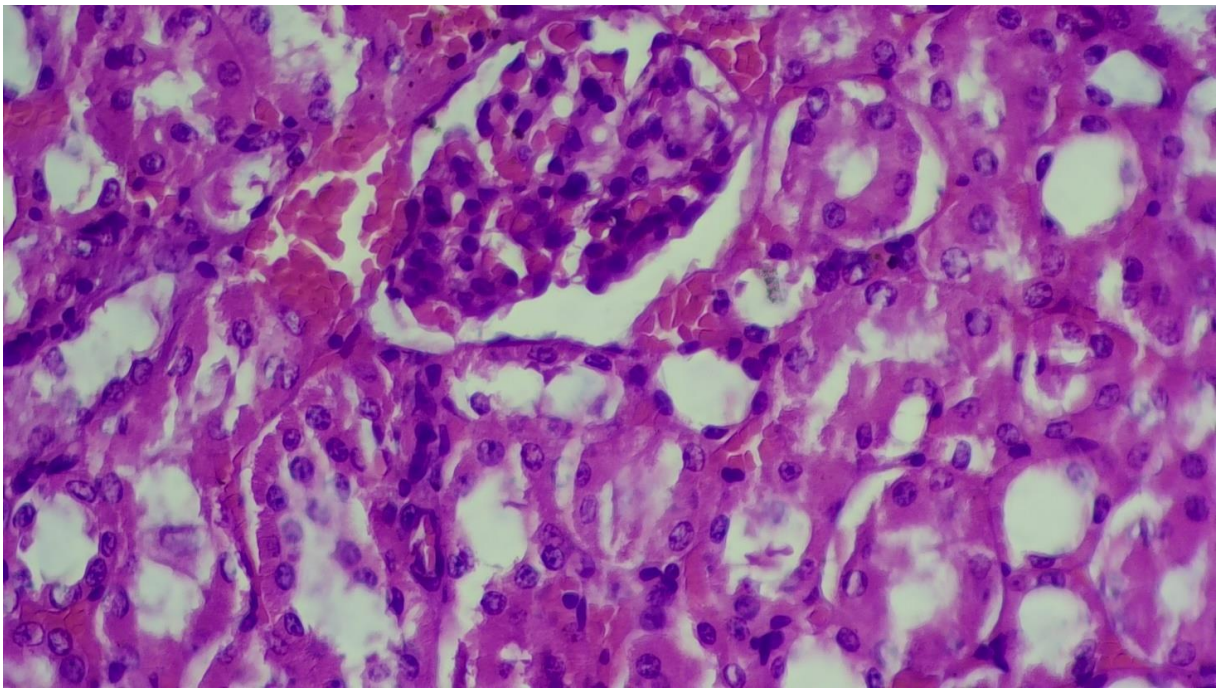


Fig 3: Normal mouse kidney showing an intact renal corpuscle with a glomerulus (G) and Bowman 's space (B S). Proximal convoluted tubules (PCT) and distal convoluted tubules (DCT) surround the corpuscle. H& E staining, ×40.

3.1.2. DMBA-Treated Group

Sections from DMBA- treated mice showed several abnormalities, mainly in the renal tubules, with less marked involvement of the glomerular regions. At low magnification (×4), the appearance and distribution of the tubular structures varied, although the overall organization of the kidney could still be recognized.

At medium magnification (×10), structural changes in the tubules were accompanied by the focal accumulations of erythrocytes within vascular or glomerular structures. These areas were suggestive of vascular congestion.

At high magnification (×40), abnormalities of the tubular epithelial cells were more evident, particularly cytoplasmic vacuolation. Vacuoles of different sizes were present within some cells, consistent with degenerative change s. The appearance of the tubular lumina also varied.

the examined sections showed renal histopathological changes in DMBA -treated animals, with the tubular epithelium accounting for most of the observed abnormalities.

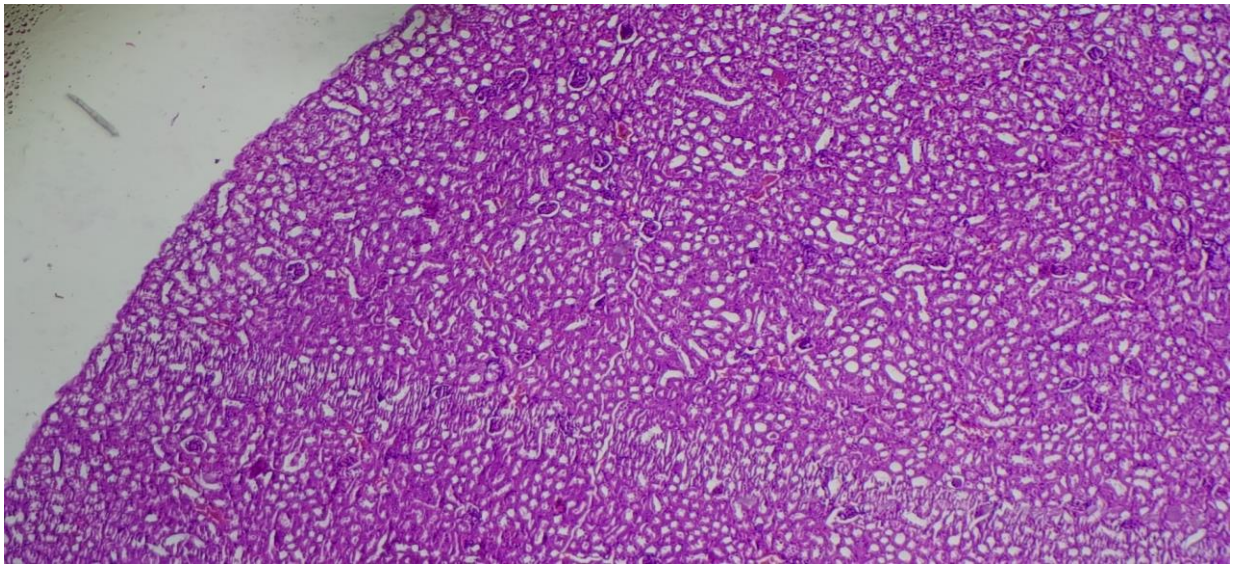


Fig 4: Low- power view of renal tissue from a DMBA-treated mouse, showing identifiable glomeruli (G) and the surrounding renal tubules (RT). H& E staining, ×4.

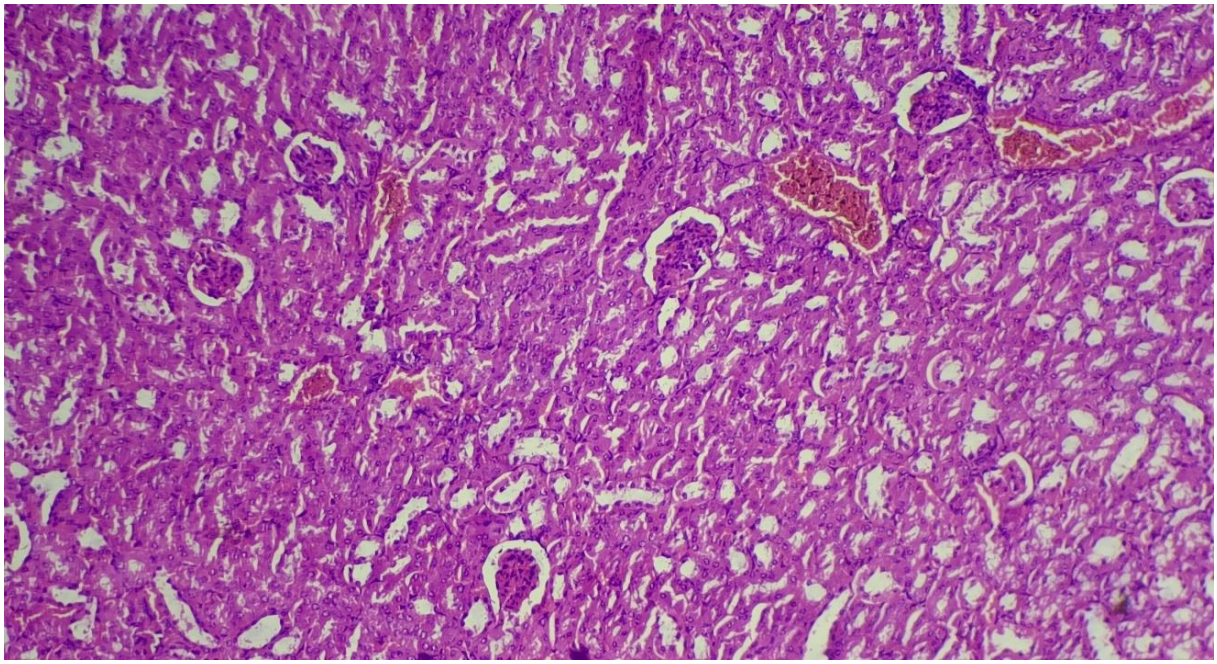


Fig 5: Kidney tissue from a DMBA-treated mouse, showing recognizable glomeruli (G), tubular alterations (TA) and a focal region suggestive of vascular congestion (VC). H&E staining, ×10.

4. Discussion

This study ass essed renal histopathological changes in female mice after oral exposure to DMBA. Several abnorm alities were identified, chiefly in the tubular epithelial cells, where intracytoplasmic vacuolation was the most prominent finding.

Control kidneys retained relatively normal glomeruli, Bowman's capsules, and surrounding tubules. In DMBA-treated mice, the tubular epithelium showed vacuolation, the tubular lumina varied in appearance and some focal areas suggested vascular congestion.

These observation agree with Öztürk *et al*. (2006), who described renal tubular injury after DMBA exposure in female mice, particularly in the proximal and distal convoluted tubules. Zeweil *et al*. (2024) [6] likewise reported DMBA- associated renal changes that included tubular degeneration and vascular abnormalities.

Vacuolation of the tubular epithelial cells may reflect oxidative injury. DMBA undergoes metabolic activation by cytochrome P 450 enzymes, generating reactive metabolites that may contribute to cellular damage (Shimada and Fujii-Kuriyama, 2004; Xue and Warshawsky, 2005) [11, 12]. Changes in antioxidant defense mechanisms after DMBA exposure have also been reported (Öztürk *et al*., 2006) [1].

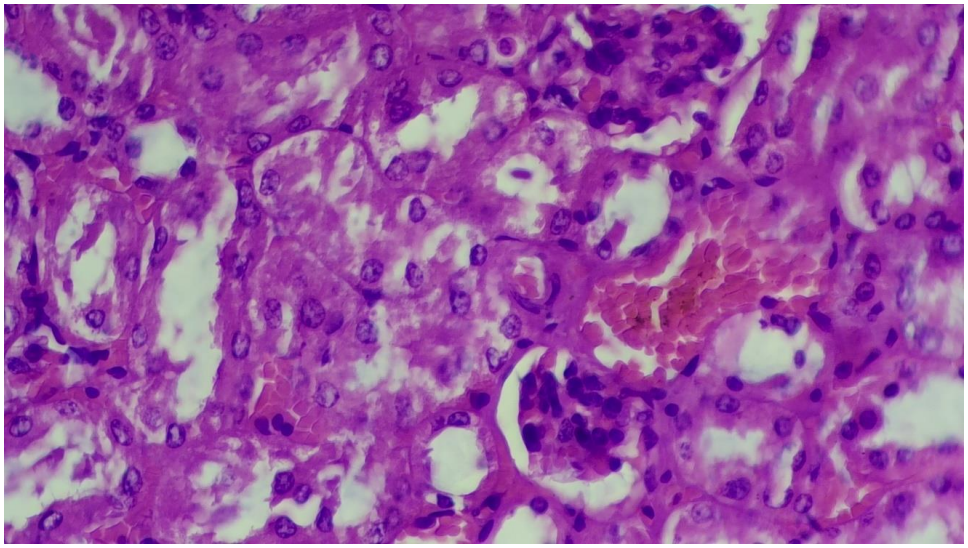


Fig 6: High-power view of kidney tissue from a DMBA -treated mouse, with marked cytoplasmic vacuolation in tubular epithelial cells (VD) and an identifiable glomerulus (G). H& E staining, ×40.

Glomerular structures could still be identified in the examined sections, although some areas contained focal erythrocyte accumulations suggestive of vascular congestion. The distribution of these changes indicates that the tubular epithelium was the main site of the observed renal abnormalities.

The findings conclude an association between repeated oral DMBA exposure and renal histopathological changes, especially vacuolation of tubular epithelial cells. Biochemical measurements and histo morphometric assessment should be future addressed to establish the mechanisms and extent of the renal injury.

5. Conclusion

Oral DMBA exposure in female mice was associated with renal histopathological changes, predominantly tubular epithelial vacuolation and focal vascular abnormalities. These observations have a potential for nephrotoxicity and indicate that renal tubular structures are susceptible to chemically induced injury. Further biochemical and molecular studies are shuld investigate the mechanisms responsible.

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