

PROPHYLACTIC ROLE OF CURCUMIN IN PROTECTING DISTAL CONVOLUTED TUBULE DIAMETER AGAINST ASPIRIN-INDUCED NEPHROTOXICITY IN ALBINO RATS

SABA AMJAD¹, HAJERA AHMED², AHMAD FAROOQ BUTT³, SADIA HAFEEZ⁴, AROOJ NAWAZ⁵, MEHWISH ZULFIQAR⁶

¹Associate Professor of Anatomy, University of Lahore, ^{2,6}Senior Demonstrator of Anatomy, University of Lahore,

³Assistant Professor of Physiology, University of Lahore, ⁴Assistant Professor of Anatomy, University of Lahore,

⁵Associate Professor of Anatomy, Azra Naheed Medical College Lahore.

ABSTRACT

Background: Aspirin is one of the widely used anti-inflammatory nonsteroidal drug worldwide, which can cause nephrotoxic effects by inhibiting prostaglandin synthesis. Curcumin, an active component of turmeric, possess anti-inflammatory and antioxidant properties that help to protect renal tubules.

Objectives: To determine the protective role of curcumin in preserving the diameter of distal convoluted tubules (DCT) after aspirin-induced renal toxicity in adult female albino rats.

Methods: A random selection of sixty albino rats was done, and then divided into four groups. Group A was labelled as the control and was given distilled water. Group B received aspirin alone, and Groups C and D received aspirin along with low and high doses of curcumin, respectively. Renal tissues were taken out for histological evaluation and for morphometric measurement of DCT diameter. ANOVA followed by Tukey's test was used for the analysis of data.

Results: The largest diameter of DCT was observed in Group A ($56.7 \pm 2.4 \mu\text{m}$). Administration of aspirin significantly decreased DCT diameter among the rats in Group B and Group C. While Group D rats showed significant preservation of diameter when compared to Group C and Group B rats, and it was statistically significant, indicated by a p-value of 0.007.

Conclusion: Curcumin showed a dose-dependent protective effect on distal tubular structures to counteract aspirin-induced nephrotoxicity.

Keywords: Curcumin, Aspirin, Distal Convoluted Tubule, Nephrotoxicity, Albino Rats.

How to cite this article: Amjad S, Ahmad H, Butt AF, Hafeez S, Nawaz A, Zulfiqar M. Prophylactic Role Of Curcumin In Protecting Distal Convoluted Tubule Diameter Against Aspirin-Induced Nephrotoxicity In Albino Rats. Pak Postgrad Med J 2026;3(3): 120-123

This is an Open Access article distributed under the terms of the Creative Commons Attribution License (<http://creativecommons.org/licenses/by/3.0>), which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.

Correspondence to: Saba Amjad

Associate Professor of Anatomy,
University of Lahore, Pakistan

Email: dr.sabawaqas14@gmail.com

Received: Feb 13, 2026; Revised: Aug 21, 2026

Accepted: Sep 07, 2026

DOI: <https://doi.org/10.51642/ppmj.v37i03.881>

INTRODUCTION

Non-steroidal anti-inflammatory drugs (NSAIDs) rank among the most widely used over-the-counter

medications globally due to their simultaneous action against fever, pain and inflammation. Acetyl salicylic acid, also known as aspirin, is one of the commonly prescribed NSAIDs. This drug acts by irreversible inhibition of cyclo-oxygenase enzymes, resulting in the disruption of arachidonic acid synthesis pathways and reduced prostaglandin formation. Due to its anti-thrombotic and antiplatelet properties, it is used as a potent drug for the prevention of cerebrovascular accidents and myocardial infarction among high-risk patients.² However, with long-term and high-dose use of aspirin, certain adverse effects like gastrointestinal bleeding,³ liver toxicity and adverse renal effects have been reported⁴. The renal effects include tubular atrophy,

interstitial nephritis and papillary necrosis. In addition to this, aspirin-induced nephrotoxicity is related to increased oxidative stress and altered hemodynamics in the renal tissue. Among other renal cells, the kidney's distal convoluted tubular cells (DCT) are also affected by these mechanisms. DCT plays a vital role in maintaining serum electrolyte balance, especially calcium and phosphate. Any structural damage to the renal tubule impairs its function, which can compromise renal homeostasis.

Curcumin (diferuloylmethane), having very strong antioxidant & anti-inflammatory properties,⁵ is a polyphenolic compound derived from the rhizome of *Curcuma longa*. These therapeutic properties of curcumin help in reducing drug-induced organ toxicities, especially nephrotoxicity. In addition, it also acts as a bactericidal agent⁶ and prevents aging.⁷ Since an increase in the oxidative stress at the cellular level is one of the major tissue injury mechanisms related to aspirin, this study aimed to explore the benefits of curcumin extract on the histopathological changes in the DCT of the kidneys against aspirin-induced nephrotoxicity.

METHODS

Ethical approval of this study was granted by the Institutional Review Board (IRB) of FPGMI, Lahore (Ref. No.F.39/22). This experimental study was conducted on 60 female Wistar albino rats weighing between 200 and 250g and aged 3-4 months. Rats were randomly divided into four groups: Group A, Group B, Group C and Group D. Each group consisted of 15 rats and was selected by using a lottery method (randomised control study). These rat groups were kept in four different and separate enclosures (cages). The rats were given a time of two weeks to adapt before the start of the experiment. Standard laboratory conditions were provided with room temperature ($24^{\circ}\text{C} \pm 5^{\circ}\text{C}$), humidity ($45\% \pm 5\%$) and alternate cycles of light (12 hrs) and dark (12 hrs). The experimental rats were given free access to standard food and water without any restriction.

Experimental Groups:

- Group A: Control group that received distilled water (10ml/kg/day)
- Group B: Administration of aspirin only (100mg/kg/day)
- Group C: Aspirin 100mg per kg per day + Curcumin 15mg/kg/day (low-dose curcumin)
- Group D: Aspirin 100mg per kg per day + Curcumin 30mg/kg/day (high dose curcumin)

Drug Administration:

Aspirin powder was obtained by crushing 1 pack of aspirin tablets (100mg). It was then mixed with 1ml of distilled water to attain a homogenous mixture. For the curcumin extraction, turmeric was purchased from the local market, and afterwards its extract was obtained

from the Pakistan Council of Scientific and Industrial Research (PCSIR), Laboratories Complex, Lahore. The procedure uses ethanol, as ethanol extraction yields the maximum curcuminoid content. It was then administered to the adult female albino rats via orogastric tube for a consecutive 30 days.⁸

Histological and Morphometric Evaluation: The rats were anaesthetised and then sacrificed on the final day of the study period. The kidneys were dissected out and fixed in 10% formalin. Subsequently, the kidney tissue was processed for histological examination. For microscopic observation, serial sections were stained with hematoxylin and eosin (H&E). The diameter of DCTs was measured from basement membrane to membrane using an ocular micrometre (40x objective). Mean values were recorded.

Statistical Analysis: Data analysis was done using SPSS version 25. For intergroup comparison, ANOVA was applied. Then Tukey's post-hoc test was done, and a P-value <0.05 was marked as significant.

RESULTS

In the current experimental study, rats from all four groups exhibited normal behaviour and appetite. They remained healthy till the completion of the experiment. ANOVA compared the diameter of DCT among A, B, C and D. Group B showed a marked decrease in diameter, whereas Group D showed an improvement in the diameter when treated with high-dose curcumin (Table 1 & Fig. 1).

DCT Diameters (Mean $\pm$ SD)

Table 1: Diameter of distal convoluted tubule of control group A, positive control group B given aspirin and experimental groups C & D given aspirin & curcumin.

Group	Mean Diameter (μm)	SD	Min.	Max.
A (Control)	56.7	2.4	5.4	61
B (Aspirin)	43.5	1.7	40	45
C (Aspirin + Curcumin Low)	42.3	3.4	33	48
D (Aspirin + Curcumin High)	45.3	1.9	43	48

Table 1 shows the mean diameter of DCT among different groups. ANOVA test showed a highly significant difference among groups ($p < 0.001$). Highly significant reduction in DCT diameter was observed in groups B and C in comparison to group A, with a p-value < 0.001 . Group D had a significantly larger DCT diameter than Group C (p value=0.007). No significant difference between Groups B and C (p value=0.493), and between Groups B and D (p value=0.223) was found.

Table 2: Group-wise comparison of the diameter of the distal convoluted tubule among animals of various groups A, B, C & D

(I) Group	(J) Group	Mean Difference (I-J)	Std. Error	P-value
Group A	Group B	13.13	0.893	0.000**
	Group C	14.40	0.893	0.000**
	Group D	11.40	0.893	0.000**
Group B	Group C	1.27	0.893	0.493+
	Group D	-1.73	0.893	0.223+
Group C	Group D	-3.00	0.893	0.007*

Based on Tukey's test.

A: Control Group of rats

B: Positive control Group of rats

C: Experimental Group I of rats

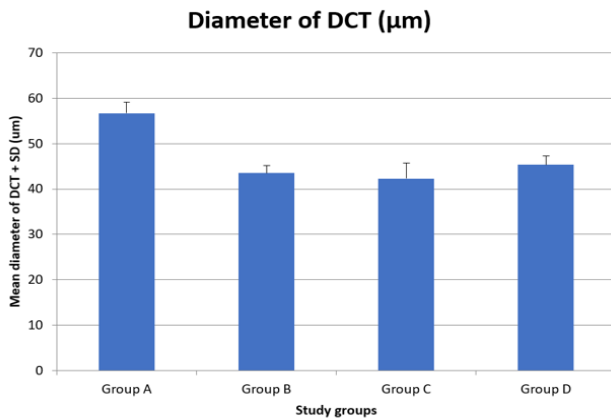
D: Experimental Group II of rats

: Highly significant difference ($P < 0.001$)

*: Significant difference ($P < 0.05$)

+: Insignificant difference ($P > 0.05$)

Fig. 1: Diameter of distal convoluted tubule of control group A, positive control group B given aspirin and experimental groups C & D given aspirin with low & high doses of curcumin.



DISCUSSION

Aspirin is a commonly used and prescribed NSAID as it has effective antiplatelet, antipyretic and anti-inflammatory properties, mainly affecting the tubular parts of the nephron. Despite its therapeutic effect, long-term use of aspirin is linked with nephrotoxicity. The present study examined significant histomorphological changes of aspirin on the distal convoluted tubules (DCT). The findings of this study are consistent with the previous studies, which have reported that the underlying mechanism of tubular degeneration involves tubular vacuolization, characteristic of NSAID-induced injury⁴. It occurs due to hypoxia, reduction in the production of ATP, free radical production, injury to mitochondria and

peroxidation damage.⁹ These effects decrease the renal perfusion, followed by structural and functional insult to DCT.

The DCT is lined by simple cuboidal epithelium and plays a pivotal role in selective reabsorption and electrolyte balance. In the present study, aspirin-treated groups B and C exhibit marked structural damage to DCT cells, characterised by narrowing of DCT diameter, both outer and luminal, along with a reduction in the number and size of distal tubular cells.¹⁰ This reduction may result from degeneration and atrophy of tubular epithelial cells following prolonged exposure to aspirin. In aspirin-treated groups, the tubular vacuolization indicates cellular injury and tubular degeneration. This highlights its ability to induce hypoxic damage with oxidative stress within renal tubular cells. Similar findings have been reported in previous experimental studies where chronic administration of nephrotoxic agents resulted in epithelial cell damage, tubular distortion and reduction in tubular dimensions.¹¹ The tubular damage not only indicates morphological deterioration but also reveals weakened tubular reabsorptive function, ultimately leading to decreased renal efficiency. In contrast, Group D, receiving a high dose of curcumin along with aspirin, demonstrated the partial preservation of luminal diameter and structure of DCT. Histological examination revealed wider tubular lumina and preserved epithelial lining when compared with aspirin-treated groups. Lipid peroxidation was prevented by the antioxidant and anti-inflammatory properties of curcumin, as well as helping to counteract reactive oxygen species (ROS).¹² Curcumin preserves the structure of tubular epithelial cells and limits oxidative stress by increasing the activity of endogenous antioxidant enzymes and stabilising cellular membranes.^{13,14}

The present study revealed a dose dependent differences in the effects of curcumin. While low-dose curcumin (Group C) failed to show a significant benefit over aspirin alone, high-dose curcumin (Group D) significantly improved structural damage, emphasising a dose-dependent protective role.

CONCLUSION

Curcumin, especially in higher doses, significantly protects and helps in preserving aspirin-induced DCT narrowing. It offers a promising prophylactic strategy against NSAID-induced nephrotoxicity. Further research on biochemical correlates and human trials is recommended.

LIMITATIONS

The sample size is small, limiting the generalizability of results. Long-term outcomes following cessation of drugs were not evaluated. Only two doses of curcumin were

evaluated, preventing a detailed evaluation of the dose-response relationship.

FUTURE RECOMMENDATIONS

Studies involving a larger sample size and multiple doses of curcumin should be conducted to determine the optimal protective dose of curcumin. Longitudinal studies are required to determine the long-term efficacy of curcumin administration. Further clinical trials are needed to evaluate the efficacy of curcumin as a protective agent against NSAID induced nephrotoxicity in humans.

ETHICAL APPROVAL

Approval of article was granted by the Institutional Review & Research Advisory Board, Shaikh Zayed Federal Postgraduate Medical Institute of Nursing & Health Sciences, Lahore vide Reference No: F-39/NHRC/Admin/IRB/228, Dated: 06 November, 2014.

AUTHOR'S CONTRIBUTIONS

SA: Literature review, data collection, data analysis, manuscript writing

HA: data collection, data analysis, manuscript writing

AFB, SH: Statistical analysis, manuscript writing

AN: Data analysis, Literature review, Manuscript writing

MZ: Literature review, proof reading

All Authors: Approval of the final version of the manuscript to be published

CONFLICT OF INTEREST

Authors declare no conflict of interest.

FUNDING SOURCE: None

REFERENCES

1. Asif S, Toor RS, Amna S, Haider A, Khan S. Mitigative effects of *Nigella sativa* on the histology of kidneys against aspirin-induced toxicity. *J Ayub Med Coll Abbottabad*. 2021;33(1):39–43. — No DOI (JAMC doesn't assign them); PMID: 33774952
2. Davidson KW, Barry MJ, Mangione CM, et al. Aspirin use to prevent cardiovascular disease: US Preventive Services Task Force recommendation statement. *JAMA*. 2022;327(16):1577–1584. <https://doi.org/10.1001/jama.2022.4983>
3. Tai FW, McAlindon ME. Non-steroidal anti-inflammatory drugs and the gastrointestinal tract. *Clin Med (Lond)*. 2021;21(2):131–134. <https://doi.org/10.7861/clinmed.2021-0039>
4. Amjad S, Saleem S, Sharif K, et al. Protective role of curcumin against aspirin-induced toxicity of proximal convoluted tubule in albino rats. *Pak Postgrad Med J*. 2022;32(3):106–109. — No DOI located (the journal does not appear to assign DOIs).
5. Kaur K, Al-Khazaleh AK, Bhuyan DJ, Li F, Li CG. A review of recent curcumin analogues and their antioxidant, anti-inflammatory, and anticancer activities. *Antioxidants*. 2024;13(9):1092. <https://doi.org/10.3390/antiox13091092>
6. Dai C, Lin J, Li H, Shen Z, Wang Y, Velkov T, Shen J. The natural product curcumin as an antibacterial agent: current achievements and problems. *Antioxidants*. 2022;11(3):459. <https://doi.org/10.3390/antiox11030459>
7. Benameur T, Soleti R, Panaro MA, La Torre ME, Monda V, Messina G, Porro C. Curcumin as prospective anti-aging natural compound: focus on brain. *Molecules*. 2021;26(16):4794. <https://doi.org/10.3390/molecules26164794>
8. Fuloria S, Mehta J, Chandel A, Sekar M, Rani NN, Begum MY, Subramaniyan V, Chidambaram K, Thangavelu L, Nordin R, Wu YS. A comprehensive review on the therapeutic potential of *Curcuma longa* Linn. in relation to its major active constituent curcumin. *Frontiers in Pharmacology*. 2022 Mar 25;13:820806. <https://doi.org/10.3389/fphar.2022.820806>
9. Zhai J, Chen Z, Zhu Q, Guo Z, Wang N, Zhang C, Deng H, Wang S, Yang G. The protective effects of curcumin against renal toxicity. *Curr Med Chem*. 2024;31(35):5661–5669. <https://doi.org/10.2174/0109298673271161231121061148>
10. AlMallah B, Al Laham S, Alkhatib R, Al-Manadili A. Evaluation of the Therapeutic Effect of Cardamom Extract on Nephropathy Induced by Aspirin in Rats Model. *Jordan Journal of Pharmaceutical Sciences*. 2025 Mar 25;18(1):146-59. No DOI located on the publisher's page.
11. LaForge JM, Urso K, Day JM, Bourgeois CW, Ross MM, Ahmadzadeh S, Shekoohi S, Cornett EM, Kaye AM, Kaye AD. Non-steroidal anti-inflammatory drugs: clinical implications, renal impairment risks, and AKI. *Advances in therapy*. 2023 May;40(5):2082-96. <https://doi.org/10.1007/s12325-023-02481-6>
12. Ragab A, Farag N, et al. Curcumin protects against diclofenac-induced renal damage in mice. *Basic Appl Zool*. 2022;83(1):7. <https://doi.org/10.1186/s41936-022-00315-5>
13. Liakopoulos V. Supplementation of antioxidants in chronic kidney disease: clinical necessity or wishful thinking? A bench to bedside translational research. *Curr Med Chem*. 2025;32(39):8783–8810. <https://doi.org/10.2174/0109298673298815240605071808z>
14. Kaur K, Al-Khazaleh AK, Bhuyan DJ, Li F, Li CG. A review of recent curcumin analogues and their antioxidant, anti-inflammatory, and anticancer activities. *Antioxidants*. 2024 Sep 6;13(9):1092. <https://doi.org/10.3390/antiox13091092>