Original Article

C-Reactive Protein as a Marker of Inflammation: Mitigation of Ulcerative Colitis in Rats by Mesalazine and Coenzyme Q10

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Abstract

Objective: This study evaluated the anti-inflammatory potential of mesalazine and Coenzyme Q10, alone and in combination, and C-reactive protein was assessed as a parameter of acute inflammation.

Methodology: Forty eight rats were divided into 6 groups. Ulcerative colitis was experimentally induced in rats and mesalazine and Coenzyme Q10 were given alone and in combination according to the grouping of animals. The kit method measured C-reactive protein levels in serum after 7 days.

Results: the group treated with a combination of mesalazine and coenzyme Q10 showed a maximum reduction in C-reactive protein levels with only 12.5% with positive or >6mg/dl levels as compared to 100% with positive or >6mg/dl value in the disease-control group.

Conclusion: The study showed that the combination of mesalazine and coenzyme Q10 has additive potential in reducing inflammation in ulcerative colitis.

Keywords: Ulcerative colitis, Mesalazine, Coenzyme Q10, C-reactive protein, Inflammation, Anti-inflammatory.

Introduction

Ulcerative colitis (UC) is a predominant inflammatory bowel disease (IBD) phenotype, a complex condition marked by epithelial injury and chronic intestinal inflammation. Characterized by a relapsing-remitting course, UC manifests clinically with abdominal pain, diarrhea, bleeding per rectum, anemia, weight loss, fever, fatigue, and pallor. UC is a major cause of lower gastrointestinal bleeding in both adults and children. While most cases are mild, severe flare-ups can still be life-threatening. Moreover, it is also associated with an increased risk of colorectal carcinoma.[1]

The pathogenesis of UC is multifactorial; influenced by genetic susceptibility and environmental factors. These risk factors are believed to disrupt the intestinal epithelial barrier that allows the transposition of luminal antigens into the underlying layers.[2] This creates an environment for an aberrant immune response, causing acute or subclinical inflammation. If this acute inflammation is not resolved, chronic intestinal inflammation develops. Immune cells like innate lymphoid cells, macrophages, and T-cells play crucial roles in responding to microbial antigens, releasing inflammatory cytokines, and producing a state of chronic inflammation in the colon.[3, 4]

UC has become a global health concern, with a raised incidence in newly industrialized Asian, African, and South American countries since 1990. Current estimates indicate an increase of 14.9% in incidence of UC globally.[5] This highlights the significant burden of IBD on public health. Despite advances in healthcare, no definitive cure for UC has been devised. The disease course has prolonged symptoms and recurrent flares which significantly impact patients' health, finances, and quality of life.[6]

Drug therapy along with some dietary modifications remains the cornerstone of managing the disease. The medicines aim primarily to induce remissions and prevent recurrences. Such therapeutic armamentarium includes 5-aminosalicylates (e.g., mesalazine, balsalazide, olsalazine), sulfasalazine, corticosteroids (e.g., prednisolone, beclomethasone, hydrocortisone), and immunomodulators (e.g., 6-mercaptopurine, methotrexate, azathioprine). Antibiotics are sometimes given as adjunctive therapy.[7, 8]

Mesalazine is a 5-aminosalicylic acid derivative and is regarded as one of the most effective agents in inducing and maintaining remissions in UC patients.[9] The exact mechanism of action is not completely comprehended, but mesalazine is believed to exert its effects by inhibiting cyclooxygenase (COX) enzymes, preventing inflammatory cell activation, and modulating inflammatory cytokines. As a result, mucosal healing is promoted, and inflammation settles.[10]

Coenzyme Q10 (Co-Q10) is an antioxidant and a pivotal part of the electron transport chain in mitochondria. It has shown promising potential in tissue healing and reducing oxidative stress, which are both implicated in pathogenesis of UC.[11] Preliminary studies indicate that Co-Q10 may have additive effects when used in conjunction with conventional UC therapy.[12]

The rat model, in which UC is induced by Dextran Sulfate Sodium (DSS), has been widely used in preclinical studies. This model offers a significant advantage over other chemically induced UC models because it is simple, reproducible, and mimics the key aspects of the disease in humans, both in symptoms and histological findings.[13]

C- Reactive Protein (CRP) is a marker of acute inflammation and is produced by the liver during flares of UC. It is an important biomarker for the diagnosis and treatment effectiveness in IBD.[14]

This study was conducted to observe the effects of mesalazine and Co-Q10 alone and as combined therapy on chemical analysis in ulcerative colitis.[15]

Methodology

Study Design and Setting: It is an animal experimental study conducted in the Pharmacology and Pathology department of KEMU and UVAS, Lahore. Ethical approval was obtained institutional review board, King Edward University Lahore with reference number is 789/RC/KEMU.

Sample Size: Sample size of 48 rats (6 groups; 8 rats in each group) is estimated by using 5% level of significance, 95% power of test with expected mean value of C-reactive protein with Mesalazine as 9.0±6.9[16] and with coenzyme Q10 as 4.294±0.14[17]

$$n \quad \frac{\sigma \ (Z_{-\alpha} \ + Z_{-\beta}{}^{2}}{(\mu \ - \mu \ )^2}$$

Where

σ^2= 12.3904 (variance)

Z_(1-α12) = 95% =1.96 (confidence level)

Z_(1-β) =90%=1.28 (power of test)

μ_0 = population mean 1= 4.29

μ_1 = population mean 2= 9.0

Substituting the values in the formula n=8 for each group.

Sampling technique: Simple random sampling

Inclusion and Exclusion criteria: Male, healthy Sprague-Dawley rats, weighing 180g to 220g were taken for experiment. Female rats and rats showing signs of any disease were rejected.

Forty-eight rats were kept in the animal house of UVAS,

Lahore and were divided into six groups randomly. Throughout the experiment, the rats were housed and fed according to the animal ethical committee guidelines. They were kept in a room with desired temperature and humidity. The rats were given unlimited access to rat chow and water. A seven-day acclimatization period was given before starting the experiment to ensure their adjustment to the environment.

Preparation of Doses & Sampling:

The dosage for each rat, 50mg/kg/day and100mg/kg/day of Mesalazine16 and 30mg/kg/day of Co-Q1017 was carefully prepared in 4% methocel solution and 0.5% carboxymethylcellulose, respectively. DSS was introduced into the drinking water of rats of B, C, D, E, and F groups. A 4% w/v solution of DSS (MW of 40-50kDa) was prepared in water. This solution was provided to the rats of experimental groups for consumption throughout the study.18

Groups of animals:

Forty eight male albino rats were assigned into six groups; each with eight rats. These groups were named A through F. Group A served as the normal control group. Group B served as the disease control group and received 4% w/v DSS dissolved in drinking water for seven days. Group C rats received mesalazine at a dose of 100 mg/kg/day orally with 4% w/v DSS in water for seven days. Group D rats were given oral Co-Q10 at a dose of 30 mg/kg/day with 4% w/v DSS in water for seven days. Group E rats got a combination treatment of mesalazine (reduced dose i.e., 50 mg/kg/day) and Co-Q10 (30 mg/kg/day) along with 4% w/v DSS in drinking water for seven days. Lastly, Group F rats received mesalazine at 100 mg/kg/day and Co-Q10 at 30 mg/kg/day with 4% w/v DSS in drinking water throughout the study.19

Sample storage:

Twenty-four hours after the last dose was administered, blood was drawn by cardiac puncture. The blood sample was stored at 4ºC.

Data collection:

The serum levels of CRP were measured using the CRP kit by ANTEC Diagnostic Products UK.

Statistical analysis:

Data was analyzed by using SPSS and GraphPad Prism. Serum CRP levels were analyzed using a clinically relevant cut-off value (>6 mg/dL) to indicate active inflammation. Based on this categorization, the chi-square test was applied. Results are presented as percentages, and a p-value of less than 0.05 was considered significant.

Results

A total of 48 male albino rats were studied into six groups; each group having eight rats. CRP level significantly rose in Group B as compared to Group A. Rats in group treated with mesalazine had lower CRP values than group B (Table 1). Similarly, serum CRP values of rats treated with Co-Q10 were also lowered towards normal. Groups treated with a combination of Co-Q10 and mesalazine in low and high doses also showed a significant reduction in C-reactive protein (Figure 1).

Discussion

This study investigated the anti-inflammatory effects of the mesalazine and coenzyme Q10 (coQ10). Dextran sulfate sodium (DSS)-induced rat models for ulcerative colitis were used and the drugs were given as monotherapy and in combination. Treatment with mesalazine or CoQ10 individually reduced the CRP levels, however, in combination therapy group, the reduction was more profound.

C-reactive protein is an acute phase reactant and is synthesized by the hepatocytes n response to interleukin-6; a pro-inflammatory cytokine. In inflammatory bowel disease, the elevated CRP levels are associated with mucosal inflammation and increased disease activity. Although CRP increase is more pronounced in crohn's disease than UC, it still serves as a valuable indicator of systemic inflammatory burden during active

Table 1. CRP in Treatment Groups:

	Group-A		Group-B		Group-C		Group-D		Group-E		Group-F		Chi-Square Test	p-value
CRP	<6	>6	<6	>6	<6	>6	<6	>6	<6	>6	<6	>6	21.33	<0.001
	8	0(0%)	0	8	5	3	4	4	6	2	7	1		
	100%	0%	0%	100%	62.5%	37.5%	50%	50%	75%	25%	87.5%	12.5%		

Group A = Normal Control Group, Group B = Disease Group, Group C = Mesalazine, Group D = Co-Q10, Group E = 1/2Mesalazine + Co-Q10, Group F = Mesalazine + Co-Q10

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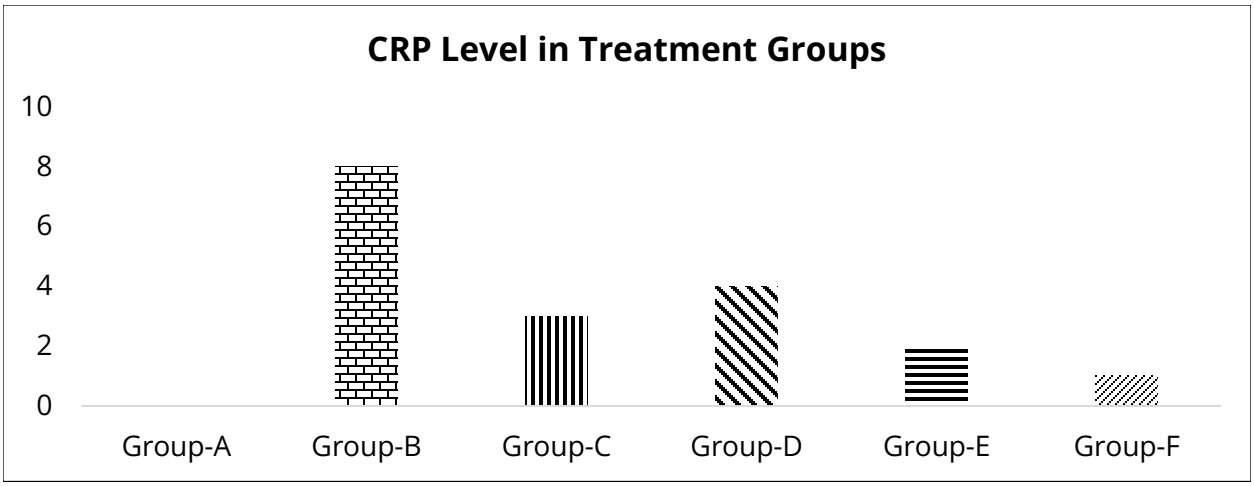

Figure 1: Graphical presentation of CRP levels among the Treatment Groups

disease states. Previous studies have demonstrated that CRP levels correlates with histopathologic disease activity in inflammatory bowel disease, thus highlighting their utility as a biomarker.[14,15]

Mesalazine is a first line treatment for UC and is used for induction and maintenance of remission in mild to moderate disease. Its mechanism is to inhibit the cyclooxygenase and lipoxygenase pathways, resulting in the attenuation of the inflammatory response by inhibiting chemotaxis of the neutrophils to the intestinal mucosa.

CoQ10 also decreases the CRP levels. It is a mitochondrial antioxidant and reduces oxidative stress. Decrease in the oxidative stress can also lead to decrease in the inflammatory response in the mucosal lining as oxidative stress plays an important role in the mucosal injury in the ulcerative colitis.[16] It is responsible for the epithelial damage, and intestinal barrier disruption. This amplifies the inflammatory signaling in ulcerative colitis.[17]

CRP level significantly rose in Group B as compared to Group A. Rats in group treated with mesalazine had lower CRP values than group B. Similarly, serum CRP values of rats treated with Co-Q10 were also lowered towards normal. Groups treated with a combination of Co-Q10 and mesalazine in low and high doses also showed a significant reduction in acute inflammatory marker, CRP. These results were similar to a study in which Bortezomib[20] and probiotic treatment mitigated UC.[21] The combination therapy of mesalazine and CoQ10 produces more profound reduction in CRP levels. This suggests a potentially enhanced anti-inflammatory effect when both agents are used together. This can be because of the complementary mechanisms of the agents by not only targeting the inflammatory response but also reducing the oxidative stress.[11]

There are several limitations of this study. One of the main limitations is the use of only CRP as the marker of inflammation. Besides this, no histological examination was done to examine the decrease in inflammation in colon tissue. Future studies should include the histological evaluation and study of other inflammatory markers as well. Molecular pathways such as cytokines, oxidative stress and signaling pathways should also be explored. Clinical studies should be done inorder to evaluate whether the combination theraoy could be beneficial in human ulcerative colitis.

Conclusion

Mesalazine and Co-Q10 alone and in combination have shown to have anti-inflammatory effects in UC. Combination of mesalazine and Co-Q10 has shown additive effects in reducing the levels of acute inflammatory maker i.e., CRP of UC in this study. Additional clinical trials are required to explore the exact mechanism of Co-Q10 and assess its potential for the therapy of UC.

References

1. Gros B, Kaplan GG. Ulcerative colitis in adults: a review. JAMA. 2023;330(10):951-965. doi: 10.1001/jama.2023.15389.
2. Kaluzna A, Olczyk P, Komosinska-Vassev K. The role of innate and adaptive immune cells in the pathogenesis and development of the inflammatory response in ulcerative colitis. J Clin Med. 2022;11(2):400. doi: 10.3390/jcm11020400.
3. Dharmasiri S, Garrido-Martin EM, Harris RJ, Bateman AC, Collins JE, Cummings JRF, et al. Human intestinal macrophages are involved in the pathology of both ulcerative colitis and Crohn disease. Inflamm Bowel Dis. 2021;27(10):1641-1652. doi: 10.1093/ibd/izab029.
4. Luo X, Villablanca EJ. Type 2 immunity in intestinal homeostasis and inflammatory bowel disease. Biochem Soc Trans. 2021;49(5):2371-2380. doi: 10.1042/BST20210535.
5. Kaplan GG, Windsor JW. The four epidemiological stages in the global evolution of inflammatory bowel disease. Nat Rev Gastroenterol Hepatol. 2021;18(1):56-66. doi:

10.1038/s41575-020-00360-x.

6. GBD 2015 Mortality and Causes of Death Collaborators. Global, regional, and national life expectancy, all-cause mortality, and cause-specific mortality for 249 causes of death, 1980-2015: a systematic analysis for the Global Burden of Disease Study 2015. Lancet. 2016;388(10053):1459-1544. doi: 10.1016/S0140-6736(16)31012-1.
7. Li L, Cheng R, Wu Y, Lin H, Gan H, Zhang H. Diagnosis and management of inflammatory bowel disease. J Evid Based Med. 2024;17(2):409-433. doi: 10.1111/jebm.12626.
8. Raine T, Bonovas S, Burisch J, Kucharzik T, Adamina M, Annese V, et al. ECCO guidelines on therapeutics in ulcerative colitis: medical treatment. J Crohns Colitis. 2022;16(1):2-17. doi: 10.1093/ecco-jcc/jjab178.
9. Li R, Huang X, Yang L, Liang X, Huang W, Lai KP, et al. Integrated analysis reveals the targets and mechanisms in immunosuppressive effect of mesalazine on ulcerative colitis. Front Nutr. 2022;9:867692. doi: 10.3389/fnut.2022.867692.
10. Beiranvand M. A review of the biological and pharmacological activities of mesalazine or 5-aminosalicylic acid (5-ASA): an anti-ulcer and anti-oxidant drug. Inflammopharmacology. 2021;29(5):1279-1290. doi: 10.1007/s10787-021-00856-1.
11. McRae MP. Coenzyme Q10 supplementation in reducing inflammation: an umbrella review. J Chiropr Med. 2023;22(2):131-137. doi: 10.1016/j.jcm.2022.07.001.
12. Pirzada H, Hameed S, Afzal A, Ali KS, Malik M, Javaid MF. Effects of mesalazine and coenzyme Q10 on colonic histology in rat model of ulcerative colitis. Esculapio. 2024;20(3):360-365. doi: 10.51273/esc24.251320410.
13. Yang C, Merlin D. Unveiling colitis: a journey through the dextran sodium sulfate-induced model. Inflamm Bowel Dis. 2024;30(5):844-853. doi: 10.1093/ibd/izad312.
14. Sakurai T, Saruta M. Positioning and usefulness of biomarkers in inflammatory bowel disease. Digestion. 2023;104(1):30-41. doi: 10.1159/000527846.
15. Vermeire S, Van Assche G, Rutgeerts P. C-reactive protein as a marker for inflammatory bowel disease. Inflamm Bowel Dis. 2004;10(5):661-665. doi: 10.1097/00054725-200409000-00026.
16. Hayashi Y, Aoyagi K, Morita I, Yamamoto C, Sakisaka S. Oral administration of mesalazine protects against mucosal injury and permeation in dextran sulfate sodium-induced colitis in rats. Scand J Gastroenterol. 2009;44(11):1323-1331. doi: 10.3109/00365520903262414.
17. Khodir AE, Atef H, Said E, ElKashef HA, Salem HA. Implication of Nrf2/HO-1 pathway in the coloprotective effect of coenzyme Q10 against experimentally induced ulcerative colitis. Inflammopharmacology. 2017;25(1):119-135. doi: 10.1007/s10787-016-0305-0.
18. Modesto R, Estarreja J, Silva I, Rocha J, Pinto R, Mateus V. Chemically induced colitis-associated cancer models in rodents for pharmacological modulation: a systematic review. J Clin Med. 2022;11(10):2739. doi: 10.3390/jcm11102739.
19. Pirzada H, Iqbal N, Fatima H, Rafique R, Malik M, Taimuri SZ. Mesalazine and coenzyme Q10: effects on disease activity index in ulcerative colitis. Esculapio. 2024;20(4):499-503. doi: 10.51273/esc24.251320314.
20. Hu LH, Fan YJ, Li Q, Guan JM, Qu B, Pei FH, et al. Bortezomib protects against dextran sulfate sodium-induced ulcerative colitis in mice. Mol Med Rep. 2017;15(6):4093-4099. doi: 10.3892/mmr.2017.6524.
21. Kamarli Altun H, Akal Yildiz E, Akin M. Effects of synbiotic therapy in mild-to-moderately active ulcerative colitis: a randomized placebo-controlled study. Turk J Gastroenterol. 2019;30(4):313-320. doi: 10.5152/tjg.2019.18356.

Authors' Contribution Statement

HP contributed to the conception, design, acquisition, analysis, drafting of the manuscript, critical review of the manuscript, and final approval of the version to be published. ZZ contributed to the design, acquisition, analysis, drafting of the manuscript, and critical review of the manuscript. WS contributed to the acquisition, analysis, interpretation of data, and drafting of the manuscript. BA contributed to the analysis, interpretation of data, and drafting of the manuscript. HT contributed to the analysis, interpretation of data, and drafting of the manuscript. ST contributed to the analysis, interpretation of data, and drafting of the manuscript. All authors are accountable for their work and ensure the accuracy and integrity of the study.

Conflict of Interest

Authors declared no conflict on interest

Grant Suppport and Financial Disclosure

None

Data Sharing Statement

The data that support the findings of this study are available from the corresponding author upon reasonable request.