Relationship of cytokines, oxidative stress and GI motility with bacterial overgrowth in ulcerative colitis patients

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Abstract

Background: Ulcerative colitis (UC) is idiopathic, chronic and relapsing inflammatory bowel disease. Factors which initiate and perpetuate UC are not well understood. It is still unclear if any relationship exists between cytokines, oxidative stress, gastrointestinal (GI) motility, and small intestinal bacterial overgrowth (SIBO) in UC patients.

Goals: To examine the relationship between these factors among UC patients.

Methods: A total of 120 UC patients and 125 age and sex matched controls with no GI symptoms were enrolled. Plasma levels of IL-6, IL-8, TNF-α and IL-10 were measured in all subjects by using ELISA. Lipid peroxidation (LPO) and reduced glutathione (GSH) were measured by standard methods. Orocecal transit time (OCTT) and SIBO were measured by lactulose and glucose hydrogen breath tests respectively.

Results: Out of the 120 UC patients, 74 were male with mean ± SD age of 45.6 ± 17.5 years. Plasma levels of IL-6, IL-8, TNF-α and IL-10 in UC patients were significantly higher (p<0.01) as compared to controls. LPO in UC patients was significantly increased (p<0.01) while GSH was significantly decreased (p<0.01) as compared to controls. OCTT and SIBO were significantly higher in UC patients as compared to controls. UC patients with elevated inflammatory cytokines showed delayed OCTT and increased SIBO. It was also observed that there was a significant correlation between SIBO with IL-6, IL-8, TNF-α, and IL-10, LPO and GSH.

Conclusion: This study indicates that increase in cytokines and decrease in anti-oxidants in UC patients would have resulted in oxidative stress causing delayed GI motility leading to SIBO.

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1. Introduction

Ulcerative colitis (UC) is a chronic inflammatory condition of the large intestine. Its etiology remains largely unknown. It is widely accepted that UC is immunemediated condition, resulting from the dysregulated contact between commensal enteric flora and the gut-associated immune system. Autoimmune mechanisms targeted against colon epithelial cells may lead to tissue damage in UC. In this scenario, a variety of proinflammatory cytokines such as TNF-α, IL-6, IL-8, and monocyte chemoattractant protein 1 are secreted at the site of inflammation. Specific antagonists such as IL-10 control these pro-inflammatory cytokines. IL-10 was originally described as cytokine synthesis inhibitory factor produced by Th2 lymphocytes. It inhibits the production of pro-inflammatory cytokines (such as TNF-α or IL-6) in cells of the monocyte–macrophage lineage. These inflammatory cells, neutrophils, and macrophages produce large amounts of reactive oxygen species (ROS) leading to oxidative stress. The augmented ROS in turn depletes intracellular GSH decreasing the GSH/GSSG ratio. Experimental data suggest that inflammation, even if mild, could lead to persistent changes in GI nerve and smooth muscle function, resulting in colonic dysmotility, hypersensitivity, and dysfunction. It has also been reported in animal studies that low-grade inflammation in the gut could alter GI motor function. Gut motility abnormalities can further predispose to bacterial overgrowth. Orocecal transit time (OCTT) and small intestinal bacterial overgrowth (SIBO) have been reported in patients with several other diseases. Although we have reported recently that delayed OCTT would have been the cause of increased SIBO in IBD patients but interrelationship of SIBO with pro-inflammatory and anti-inflammatory cytokines, oxidative stress and GI motility has not yet been established in UC patients. Therefore, to understand the pathology of UC, this study was designed to examine relationship of cytokines, oxidative stress and GI motility with SIBO among UC patients.

2. Materials and methods

A total of 120 patients (with age range 20–67 years) with ulcerative colitis were prospectively enrolled in this study. Twenty-eight patients were excluded according to exclusion criteria. UC was diagnosed on the basis of clinical, radiological, colonoscopy and histological findings. These patients were on clinical remission state and taking 5-aminosalicylic acid (5-ASA). All enrolled patients had complete cessation of rectal bleeding and normal stool frequency since 5–6 months. One hundred and twenty five patients gave their consent for participation in the study. The study was done from May 2009 to December 2012. None of the patients on spironolactone were enrolled, because this drug inhibits the pro-inflammatory cytokines.

2.1. Inclusion criteria

- UC patients who were in clinical remission state from the last 5–6 months and on maintenance therapy with 5-aminosalicylic acid.
- Subjects who gave their consent for participation in the study.
- Individual with age ≥18 years and ≤70 years.
- Confirmed UC patients on the basis of clinical, radiological, colonoscopy and histological findings were included.

2.2. Exclusion criteria

- Patients with diabetes, hepatic changes, acute infections, other chronic inflammatory diseases and pregnancy were excluded as these patients may have disturbed autonomic functions, which may lead to delayed GI motility.
- UC patients who underwent colectomy.
- All Crohn’s disease (CD) patients were excluded.
- Patients with short bowel syndrome, stenosis and fistulas were also excluded.
- Patients taking antibiotics and probiotics within one month of hydrogen breath test were excluded from the study.
- None of the patients on spironolactone were enrolled, because this drug inhibits the pro-inflammatory cytokines.

2.3. Blood collection and preparation of plasma and hemolysate

Twelve hour fasting venous blood samples were drawn from patients and controls. Blood was collected in EDTA vials. Plasma was separated immediately in cold conditions. Erythrocytes were washed thrice with ice-cold normal saline and then lysed by adding ice-cold distilled water. Plasma and hemolysate were stored at −80°C till further use. Hemolysate was used for the assay of lipid peroxidation (LPO), reduced glutathione (GSH) and plasma for the measurement of IL-6, IL-8, TNF-α and IL-10 cytokines.

2.4. Cytokine assays

Plasma measurement of IL-6, IL-8, TNF-α and IL-10 cytokines was carried out by ELISA method. Plasma samples of UC patients and controls were processed at the same time for proper comparison. ELISA kits were obtained from Diaclone, France.

2.5. Oxidative stress status

Oxidative stress was assayed in all the subjects by monitoring lipid peroxidation by using the method of Ohkawa et al.

2.6. Antioxidant defense status

GSH in hemolysate was estimated using 5,5′-dithio bis-2-nitrobenzoic acid (DTNB) according to Ellman method.
2.7. Glucose hydrogen breath test for SIBO

Patients were instructed to eat a low fiber diet for 3 days before the glucose hydrogen breath test. They were given 80 g of glucose in 350 ml of water to drink after taking a basal end expiratory breath. Then, breath samples were collected at 15-min intervals for 2 h. Breath hydrogen (H2) concentration was measured by gas chromatography using SC Microlyzer (QuinTron Instrument Co., USA). An increase in breath H2 concentration ≥ 12 ppm over baseline value in two consecutive readings within 2 h was defined as SIBO.

2.8. Lactulose hydrogen breath test for OCTT

It was measured by using 15 ml of lactulose syrup containing 10 g of lactulose. Patients were asked to give an end expiratory breath after 12-hour fast. They were also advised not to consume high fiber diet 3 days before the test because these foods may cause prolonged excretion of hydrogen gas and a high fasting value which may lead to false negative results. Cigarette smoking and exercise were not allowed for at least 2 h before and during the test. End expiratory breath samples were taken after every 15 min up to 4 h. Samples were analyzed for hydrogen concentration using H2 breath analyzer from Quintron, USA. Time taken for the rise of ≥ 12 ppm over the baseline value in two consecutive readings was considered as the OCTT. In the case of SIBO positive patients two distinct peaks were observed and their OCTT was calculated on the basis of second peak.

2.9. Statistical analysis

Values are given as mean ± SD. Statistical analysis for plasma cytokine levels, LPO and GSH between UC patients and healthy controls was done using unpaired student’s t-test. χ2 test was used to analyze the presence of SIBO in both groups. Student’s unpaired t test was applied to compare the OCTT between the study and control groups and between SIBO-positive and negative UC patients. Correlation of SIBO with IL-6, IL-8, TNF-α, and IL-10 cytokines, LPO and GSH was done. All statistical analyses were performed by using SPSS version 16.0 for Windows (SPSS, Inc., Chicago, IL). Difference was considered significant at p < 0.05 level.

3. Results

3.1. Subject characteristics

Out of the 120 UC patients, 74 (61.7%) were male with mean ± SD age of 45.6 ± 17.5 years while in controls 73/125 (58.4%) male with mean ± SD age of 44.7 ± 19.5 years. There were 46/120 (38.3%) female with mean ± SD age of 43.9 ± 20.4 years in UC patients and 52/125 (41.6%) female with mean ± SD age of 45.2 ± 18.7 years in controls.

3.2. Levels of pro-inflammatory cytokines in ulcerative colitis patients and controls

There was a significant increase (p < 0.01) in plasma levels of pro-inflammatory cytokines i.e. IL-6, IL-8 and TNF-α in UC patients as compared to healthy controls (Table 1).

3.3. Levels of anti-inflammatory cytokine in ulcerative colitis patients and controls

There was a significant increase (p < 0.01) in plasma levels of IL-10 in UC patients as compared to healthy controls (Table 1).

3.4. Comparison of lipid peroxidation in ulcerative colitis patients and controls

There was a significant increase (p < 0.01) in levels of LPO in UC patients as compared to healthy controls (Table 2).

3.5. Comparison of reduced glutathione in ulcerative colitis patients and controls

Levels of GSH in UC patients were significantly reduced (p < 0.01) as compared to healthy controls (Table 2).

3.6. OCTT in ulcerative colitis patients and controls

Mean ± SD (125.2 ± 49.7 min) of OCTT in UC patients was significantly higher (p < 0.01) as compared to OCTT (91.7 ± 28.3 min) in controls. It has also been observed that OCTT was significantly higher (p < 0.01) in SIBO positive

Table 1

<table>
<thead>
<tr>
<th>Cytokine (pg/ml)</th>
<th>UC patients (n = 120)</th>
<th>Controls (n = 125)</th>
<th>t value</th>
<th>df</th>
<th>p value</th>
</tr>
</thead>
<tbody>
<tr>
<td>IL-6</td>
<td>18.7 ± 9.36</td>
<td>3.71 ± 2.10</td>
<td>17.45</td>
<td>243</td>
<td>&lt;0.01*</td>
</tr>
<tr>
<td>IL-8</td>
<td>204 ± 138.0</td>
<td>23.9 ± 2.10</td>
<td>14.62</td>
<td>243</td>
<td>&lt;0.01*</td>
</tr>
<tr>
<td>TNF-α</td>
<td>11.8 ± 6.80</td>
<td>5.48 ± 2.0</td>
<td>9.95</td>
<td>243</td>
<td>&lt;0.01*</td>
</tr>
<tr>
<td>IL-10</td>
<td>5.37 ± 1.89</td>
<td>2.91 ± 1.4</td>
<td>11.6</td>
<td>243</td>
<td>&lt;0.01*</td>
</tr>
</tbody>
</table>

* p < 0.01 between patients and controls.

Table 2

<table>
<thead>
<tr>
<th>Oxidative Stress (μmol/gmHb)</th>
<th>UC patients (n = 120)</th>
<th>Controls (n = 125)</th>
<th>t value</th>
<th>df</th>
<th>p value</th>
</tr>
</thead>
<tbody>
<tr>
<td>LPO</td>
<td>6.08 ± 1.10</td>
<td>4.25 ± 0.52</td>
<td>16.75</td>
<td>243</td>
<td>&lt;0.01*</td>
</tr>
<tr>
<td>GSH</td>
<td>0.85 ± 1.2</td>
<td>3.14 ± 0.57</td>
<td>-19.19</td>
<td>243</td>
<td>&lt;0.01*</td>
</tr>
</tbody>
</table>

* p < 0.01 between patients and controls.
UC patients and controls as compared to SIBO negative subjects (Table 3).

### 3.7. Incidence of SIBO in patients with ulcerative colitis and controls

Incidence of SIBO in UC patients (15%) was significantly higher \((p < 0.01)\) as compared to controls (1.6%) (Table 3).

### 3.8. Cytokines and oxidative stress in SIBO positive and negative subjects

Pro-inflammatory cytokines (IL-6, IL-8, and TNF-\(\alpha\)), anti-inflammatory cytokine (IL-10), and LPO (marker of oxidative stress) were significantly higher \((p < 0.01)\) in SIBO positive UC patients as compared to SIBO negative patients. In contrast, GSH (marker of antioxidants) was significantly decreased \((p < 0.01)\) in SIBO positive UC patients as compared to SIBO negative patients (Table 4).

### 3.9. OCTT and frequency of SIBO in presence and absence of increased pro- and anti-inflammatory cytokines in UC patients

OCTT and frequency of SIBO were significantly higher \((p < 0.01)\) in UC patients with elevated inflammatory cytokines (Table 5).

### 3.10. Correlation of SIBO with cytokines, oxidative stress and antioxidant markers

Correlation of SIBO with cytokines, oxidative stress and antioxidants is shown in Table 6. It was observed that there was a positive correlation of SIBO with IL-6, IL-8, TNF-\(\alpha\), and IL-10 cytokines and LPO. On the other hand, negative correlation was observed between SIBO and GSH.

### 4. Discussion

Ulcerative colitis is a chronic inflammatory bowel disease characterized by continuous inflammation of the intestinal lamina propria. Its pathogenesis involves many different factors, such as genetic susceptibility, environmental triggers, and immune response, which all are necessary, but none of them is sufficient itself to induce the disease. Cytokines play a key role in initiation, augmentation, and perpetuation of the disease, since they are directly responsible for the mucosal injury. In the present study, levels of circulating pro-inflammatory cytokines (IL-6, IL-8, TNF-\(\alpha\)) and anti-inflammatory cytokine (IL-10) in ulcerative colitis (UC) patients have been compared with controls. These sets of cytokines, produced by antigen presenting cells, promote inflammatory host reactions in response to various damaging agents.\(^{22}\) IL-6 is a typical pro-inflammatory cytokine and its main source in the gut is the macrophages. Increased IL-6

### Table 3  OCTT in SIBO positive and negative patients of ulcerative colitis and controls.

<table>
<thead>
<tr>
<th></th>
<th>UC patients (n = 120)</th>
<th>Controls (n = 125)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>SIBO positive patients</td>
<td>SIBO negative patients</td>
</tr>
<tr>
<td>Number (%)</td>
<td>18/120 (15%)</td>
<td>102/120 (85%)</td>
</tr>
<tr>
<td>OCTT (minutes) (Mean ± SD)</td>
<td>156.3 ± 44.2</td>
<td>105.7 ± 48.3</td>
</tr>
<tr>
<td>t value</td>
<td>8.54</td>
<td>26.7</td>
</tr>
<tr>
<td>df</td>
<td>243</td>
<td>243</td>
</tr>
<tr>
<td>p value</td>
<td>p &lt; 0.01 *</td>
<td>p &lt; 0.01 *</td>
</tr>
</tbody>
</table>

* p < 0.01 between SIBO positive and negative.

### Table 4  Pro- and anti-inflammatory cytokines (pg/ml), LPO (\(\mu\)mol/gmHb) and GSH (\(\mu\)mol/gmHb) levels in SIBO positive and negative UC patients.

<table>
<thead>
<tr>
<th></th>
<th>UC patients (n = 120)</th>
<th></th>
<th>t value</th>
<th>df</th>
<th>p value</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>SIBO positive patients</td>
<td>SIBO negative patients</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(n = 18)</td>
<td>(n = 102)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>IL-6</td>
<td>20.1 ± 8.50</td>
<td>4.86 ± 3.12</td>
<td>13.77</td>
<td>118</td>
<td>p &lt; 0.01 *</td>
</tr>
<tr>
<td>IL-8</td>
<td>214.3 ± 125.4</td>
<td>27.6 ± 2.34</td>
<td>15.32</td>
<td>118</td>
<td>p &lt; 0.01 *</td>
</tr>
<tr>
<td>TNF-(\alpha)</td>
<td>15.5 ± 8.3</td>
<td>6.45 ± 2.3</td>
<td>9.31</td>
<td>118</td>
<td>p &lt; 0.01 *</td>
</tr>
<tr>
<td>IL-10</td>
<td>6.72 ± 2.10</td>
<td>3.5 ± 1.8</td>
<td>6.82</td>
<td>118</td>
<td>p &lt; 0.01 *</td>
</tr>
<tr>
<td>LPO</td>
<td>7.12 ± 1.5</td>
<td>4.83 ± 0.59</td>
<td>11.35</td>
<td>118</td>
<td>p &lt; 0.01 *</td>
</tr>
<tr>
<td>GSH</td>
<td>0.74 ± 1.1</td>
<td>2.95 ± 0.43</td>
<td>−12.54</td>
<td>118</td>
<td>p &lt; 0.01 *</td>
</tr>
</tbody>
</table>

* p < 0.01 between SIBO positive and negative UC patients.
levels were found in both biopsy samples and sera of UC patients as observed by Reimund et al.23 Interleukin-8 (IL-8) is responsible for neutrophil-activating actions during inflammatory response. Umehara et al.24 observed that plasma levels of IL-6 and IL-8 significantly reflect the presence of disease in patients with UC. In the present study, also the levels of IL-6 and IL-8 were elevated in UC patients as compared to controls. TNF-α is also a pro-inflammatory cytokine that plays an integral role in the pathogenesis of ulcerative colitis. Furthermore, increased TNF-α level has been demonstrated in studies of patients with ulcerative colitis,25,26 which is similar to the results obtained in the present study. However, a study by Umehara et al.24 demonstrated that TNF-α level remained within the normal range in most of the cases despite being in the active phase of disease among UC patients. In contrast, we observed increased levels of TNF-α in UC patients of our study. Moreover, according to published literature controversial reports are available regarding cytokine levels in active and remission UC. In one of the reports, active and remission UC showed no difference in pro-inflammatory cytokine (TNF-α) levels.27 IL-10 is an anti-inflammatory cytokine produced by T cells, B cells, and monocytes, in the presence of an antigenic stimulus. The analysis of cytokine mRNA levels by real-time quantitative reverse transcription-polymerase chain reaction (RT-PCR) in T lymphocytes of UC patients and healthy controls showed a significant increase of IL-10 in UC, while it was undetectable in healthy colonic lamina propria.28 IL-10 was also elevated in plasma of patients with UC, suggesting that IL-10 acts as a naturally occurring damper in the acute inflammatory process of UC. Similar results of elevated IL-10 were observed in the present study. It has been reported that inflammatory process induces oxidative stress and reduces cellular antioxidant capacity.31 The presence of ROS is generally measured indirectly by the levels of oxidatively damaged molecules. Oxidative stress has been well documented in UC with increased ROS and decreased antioxidant levels in the inflamed mucosa, which ultimately contribute to chronic tissue damage.32 Lipid oxidation can be assessed in a variety of tissues and fluids by measuring the levels of thiobarbituric acid reactive substances (TBARS), diene conjugation and isoprostanes.33 Contradictory results are present in literature with respect to plasma lipid peroxidation in UC patients. A study by Durak et al.34 showed that MDA levels in UC patients were significantly lower compared to controls, showing that mucosa was not under oxidative stress and that the defense mechanism was not reduced. Tuzun et al.35 have demonstrated that plasma MDA levels were similar between UC patients and controls. This was consistent with a study by Bhaskar et al.36 However, we observed in the present study that the oxidative stress generated in UC patients produced oxidative damage as demonstrated by an increase in lipid peroxidation (malondialdehyde formation). Glutathione is important in the regulation of the redox state, and a decline in its level has often been considered to be indicative of increased oxidative stress and decreased antioxidant levels.37 The present study showed that the levels of GSH were diminished in UC patients which may be consumed for the removal of free radicals in UC patients.

Intestinal inflammation and immune activation can also alter GI motility, associated with altered function of enteric nerves, intestinal cell of Cajal (ICCs) or smooth muscles. Animal studies indicated that low-grade inflammation in the gut could alter GI motor function.38,39 In the present study, delayed OCTT was observed which would have been due to inflammation leading to altered immune activation and oxidative stress. We also observed in the present study that SIBO was significantly higher in UC patients as compared to controls. Furthermore, deferred OCTT was also observed in SIBO positive UC patients as compared to SIBO negative

### Table 5: OCTT and frequency of SIBO in presence and absence of increased pro- and anti-inflammatory cytokines in UC patients.

<table>
<thead>
<tr>
<th>Cytokine</th>
<th>OCTT Mean ± SD</th>
<th>p value</th>
<th>SIBO + ve</th>
<th>p value</th>
</tr>
</thead>
<tbody>
<tr>
<td>IL-6</td>
<td>&gt;8 pg/ml (n = 23) 141.5 ± 40.9</td>
<td>p &lt; 0.01</td>
<td>16 (69.5%)</td>
<td>p &lt; 0.01</td>
</tr>
<tr>
<td></td>
<td>&lt;8 pg/ml (n = 97) 117.1 ± 38.9</td>
<td>02 (2.06%)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>IL-8</td>
<td>(&gt;28 pg/ml (n = 25) 153 ± 41.4</td>
<td>p &lt; 0.01</td>
<td>17 (68%)</td>
<td>p &lt; 0.01</td>
</tr>
<tr>
<td></td>
<td>(&lt;28 pg/ml (n = 95) 120.7 ± 39.6</td>
<td>01 (1.05%)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>TNF-α</td>
<td>(&gt;10 pg/ml (n = 28) 149 ± 37.5</td>
<td>p &lt; 0.01</td>
<td>17 (60.7%)</td>
<td>p &lt; 0.01</td>
</tr>
<tr>
<td></td>
<td>(&lt;10 pg/ml (n = 92) 119.8 ± 42.3</td>
<td>01 (1.08%)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>IL-10</td>
<td>(&gt;6 pg/ml (n = 21) 158.5 ± 42.9</td>
<td>p &lt; 0.01</td>
<td>15 (71.4%)</td>
<td>p &lt; 0.01</td>
</tr>
<tr>
<td></td>
<td>(&lt;6 pg/ml (n = 99) 123.4 ± 38.2</td>
<td>03 (3.03%)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* p < 0.01 between presence and absence of elevated inflammatory cytokines.

### Table 6: Correlations of small intestinal bacterial overgrowth (SIBO) with IL-6, IL-8, TNF-α, IL-10, LPO, and GSH.

<table>
<thead>
<tr>
<th></th>
<th>IL-6</th>
<th>IL-8</th>
<th>TNF-α</th>
<th>IL-10</th>
<th>LPO</th>
<th>GSH</th>
</tr>
</thead>
<tbody>
<tr>
<td>SIBO</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pearson correlation</td>
<td>0.636a</td>
<td>0.360a</td>
<td>0.365a</td>
<td>0.518a</td>
<td>0.713a</td>
<td>−0.577a</td>
</tr>
<tr>
<td>Sig. (2-tailed)</td>
<td>0.000</td>
<td>0.002</td>
<td>0.000</td>
<td>0.000</td>
<td>0.000</td>
<td>0.000</td>
</tr>
<tr>
<td>N</td>
<td>120</td>
<td>120</td>
<td>120</td>
<td>120</td>
<td>120</td>
<td>120</td>
</tr>
</tbody>
</table>

* Correlation is significant at the 0.01 level (2-tailed).
patients. Delayed OCTT would have been the cause of increased SIBO in UC patients. In the present study it has also been observed that OCTT was delayed in UC patients with elevated inflammatory cytokines which would have been the reason of increased SIBO in these patients. The jejunal aspiration is the gold standard test for confirmation of small intestinal bacterial overgrowth. However, invasiveness is the key limitation with jejunal aspiration and there are chances of contamination. Major development has been made with hydrogen breath testing, which can evaluate intestinal transit time with lactulose and small intestinal bacterial overgrowth with glucose, because glucose-hydrogen breath test has higher diagnostic value. Therefore, non-invasive glucose hydrogen breath test was used in the present study to evaluate SIBO. By analyzing the results of the present study, it seems reasonable to speculate that delayed OCTT and presence of SIBO can play an important role in the manifestations of UC.

The findings of the present study clarify that the presence of SIBO in UC patients is directly proportional to the increased IL-6, IL-8, TNF-α, IL-10 inflammatory cytokines and LPO, the value of one variable increases with the increase in other. Whereas, analyzing the relation of SIBO with GSH, it has been observed that it was inversely proportional indicating that with an increase in one variable the other decreases.

Taken together, the results of the present study suggest that an imbalanced and inefficient IL-6, IL-8, TNF-α, IL-10, LPO and GSH levels in UC patients may have contributed to alter the GI motility leading to increased SIBO in these patients.

5. Conclusion

This study indicates that UC patients had increased levels of pro-inflammatory cytokines i.e. IL-6, IL-8 and TNF-α and anti-inflammatory cytokine i.e. IL-10. The data provide evidence that disturbed equilibrium between pro- and anti-inflammatory cytokines plays a significant role in the pathogenesis of UC. This study also indicates that patients with UC had increased levels of LPO while the level of reduced glutathione was significantly decreased showing oxidative stress. OCTT was significantly delayed in UC patients having elevated inflammatory cytokines. This would have been the cause of increased SIBO in UC patients.

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References