Nutritional status of patients with Crohn's disease

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Background and Aim: Malnutrition is a common feature in patients with Crohn’s disease (CD), which leads to frequent infections and poor prognosis. In view of the rising incidence of CD in India we planned this study to assess the nutritional status of patients with CD.

Methods: Nutritional status of 112 patients (mean age 35.9 [SD 11.7] years; 61 men) with CD was assessed by anthropometric, dietary and biochemical parameters. Patients were considered malnourished if 3 or more anthropometric parameters (% ideal body weight [IBW], % tricep skin fold [TSF], %mid upper arm circumference [MUAC], and % mid arm muscle circumference [MAMC], body mass index [BMI]) were abnormal. Dietary intake was assessed by a 24-hour dietary recall along with a semi-quantitative food frequency method. Eighty volunteers were taken as healthy controls (HC).

Results: At the time of assessment, 77 patients were in remission and 35 had active disease. The values of BMI, MUAC, TSF and mid arm fat area (MAFA) in patients were significantly lower than those in healthy controls. MAMC and mid arm muscle area (MAMA) of patients and controls were comparable. TSF (Rem vs HC = 10.4 [2.8–71] vs 16 [3–41]) and MAFA (Rem vs HC = 1236 [240–7757] vs 1858 [322–5650]) of the patients in the remission phase were significantly lower than those of healthy controls; the remaining parameters were comparable. There was no difference in the dietary intake of patients in the remission and active phases, and healthy controls. The percentage energy fulfillment of the patients was lower than that of healthy controls. Twenty-nine of 35 (82.8%) patients in the active and 30 of 77 (38.9%) patients in the remission phase were malnourished (OR 7.5, 95% CI 2.8 – 20.4). The overall prevalence of malnutrition was 52.6% among patients.

Conclusion: The percentage of malnourished patients in the active and remission phases of the disease was 82.8% and 38.9%, respectively, possibly due to low percentage energy fulfillment.


Nutritional status of patients is significantly altered in inflammatory bowel diseases (IBD) such as Crohn’s disease (CD). Depending upon the disease activity and the nature of parameters assessed, protein–energy malnutrition is reported in 20%–85% in patients with CD. Multiple factors such as inadequate intake, anorexia, increased gastrointestinal losses, malabsorption, enhanced nutritional requirements and oxidative stress, could contribute to malnutrition. This results in nutritional deficiencies that can occur even when the disease is quiescent. Undernourished patients develop complications such as poor wound and fistula healing, muscle wasting, depressed immunity, frequent infection and relapses, thereby leading to a poor prognosis and quality of life.

In view of the rising incidence of CD in India, we assessed the nutritional status of patients with CD, and to compare the nutritional status in the remission and active phases of the disease.

Methods

Patients

One hundred and twelve consecutive patients with CD, attending the outpatient and inpatient section of the Department of Gastroenterology at our institute, were studied between May 2005 and May 2007. The diagnosis of CD was made on the basis of clinical manifestations (chronic diarrhea, hematochezia, abdominal pain and intestinal obstructive symptoms), endoscopic features (skip lesions, asymmetrical involvement, deep ulcers, aphthous ulcers, involvement of the ileocecal valve and terminal ileum), and histological evidence (inflammation extending beyond muscularis mucosae, lymphoid follicles and non-caseating granuloma). Disease activity was assessed using the Crohn’s Disease Activity Index (CDAI). The location and behavior of the disease were classified using the modified Montreal classification.
**Healthy controls**

Eighty healthy subjects comprising hospital staff and attendants of patients with a diagnosis other than IBD were included as controls. All were in good health as assessed by medical history and physical examination. None of the subjects were habitual smokers or had a history of chronic alcohol abuse. The study was approved by the Ethics Committee of our institution.

**Nutritional assessment**

A detailed nutritional assessment of the patients and healthy controls was conducted as follows.

Anthropometric measurements included height, weight, tricep skin fold (TSF), mid-upper arm circumference (MUAC), mid-arm muscle circumference (MAMC), mid-arm muscle area (MAMA) and mid-arm fat area (MAFA). Height was measured by a standardized scale to the nearest of 0.1 cm, using a wall-mounted stadiometer. Body weight was measured with minimum clothing, using an electronic scale with a digital readout to an accuracy of 0.01 kg. Body mass index (BMI) was calculated from height and weight (kg/m$^2$).

Mid-upper arm circumference (MUAC) was measured to an accuracy of 0.1 cm with a non-stretchable tape. Triceps skinfold thickness (TSF) was measured using Harpenden calipers, at the mid point between the acromion and the olecranon processes. All the measurements were taken on the non-dominant arm. From the MUAC and TSF, MAMC, MAFA and MAMA were calculated by the following formulae.9

1) MAMC: MUAC – ($\pi \times$ TSF)  
2) MAMA: (MAMC$^2$)/4$\pi$  
3) MAFA: (TSF $\times$ MUAC – $\pi$)/2 $\times$ (TSF$^2$)/4

Except for BMI, the observed values of weight, TSF, MUAC, MAMC were compared with the standard values from the reference population and expressed as a percentage of ideal standards, i.e. TSF (M = 12.5 mm, F = 16.5 mm)10 MUAC (M = 26.4 cm, F = 25.7 cm)$^{11}$ and MAMC (M = 25.3 cm, F = 23.2 cm).10 The ideal body weight (IBW) was calculated making use of the Broca index: [IBW for men = (height in cm – 100), IBW for women = (height in cm – 105)].

Patients were classified as malnourished if three or more of %IBW, BMI, %TSF, %MUAC, %MAMC values were abnormal (Table 1).

**Dietary intake**

The dietary intake was assessed by a 24-hour dietary recall along with a semi-quantitative food frequency method.12 The recall comprised the usual intake throughout the day including the mid morning and evening snacks. Information regarding the frequency of consumption of items from different food groups and their quantity was also noted. Standardized set of bowls, glasses and spoons along with food models of ‘rotis’ were used for exact quantification of the amount ingested by the subjects. Information was also collected about the types and amount of fat used as a cooking medium. A note was taken if any food restrictions and special dietary changes were made in the recent past by the patients. The macronutrients (energy, protein, carbohydrates, and fat) were calculated using the computerized nutrient evaluation programme (CNIEP) based on the Indian food composition tables by the Indian Council of Medical Research.13 The energy requirement was assessed by the Harris Benedict equation for men and women.14 The physical activity factor was taken as 1.2 for bed-ridden patients and 1.3 for the ambulatory patients. The injury factor was decided according to the disease activity as assessed by the CDAL (<150 = 1.1, 151–220 = 1.2, 221–400 = 1.3, >400 = 1.5).14 For healthy controls, the physical activity factor was taken as 1.2 for sedentary workers and 1.3 for moderate workers.

**Biochemical parameters**

After an overnight fast, a venous blood sample was obtained from the patients only and analyzed for total protein, serum albumin, calcium and hemoglobin.

**Statistical analysis**

STATA 9.0 (College station, TX, USA) statistical software was used for data analysis. The data were expressed as mean (SD) and median (range). The difference in proportions for the catagorical data was compared using $\chi^2$ test. Non-parametric test, Kruskal Wallis test and Wilcoxon rank sum tests were used for the variables TSF, MAMA, MAFA, energy, protein and fat intake. The remaining variables between patients and healthy controls were compared using the independant t-test. Remission, active disease and healthy controls were compared using ANOVA. Odds ratio (OR) is expressed with 95% confidence interval (CI). The pvalue of <0.05 was considered statistically significant.

**Results**

The mean age of 112 patients was 35.9 (11.7) (range 18–66) years. There were 61 men (54.4%). The mean duration of disease was 71.8 (74.03) (range 3–432) months. The duration of disease was <36 months in 44 patients (39.3%) and >36 months in 68 (60.7%) patients.
Thirteen patients (11.6%) had small intestine involvement only, 58 (51.8%) had colonic involvement only, while 41 (36.6%) had both small and large intestine involvement. Seventy-two patients (64.3%) had ulcerative disease, 31 (27.7%) had strictureing and 9 (8.0%) had fistulizing disease. Twenty-one patients (18.8%) had involvement of the upper GI tract and 43 (38.3%) had extraintestinal manifestations. Seventy-seven patients (68.8%) were in remission (CDAI<150), and 35 (31.3%) had active disease (CDAI >150). The mean age of healthy controls was 32.8 (8.6) (range 18–62) years. There were 42 (52.5%) men. Patients in the active and remission phases of the disease had similar distribution with regards to location of the disease, presence of extraintestinal manifestations, history of alcohol intake and smoking.

**Anthropometric parameters**

There was a significant difference in weight, BMI (p<0.05), MUAC (p<0.02), TSF and MAFA (p<0.001) of the patients compared with healthy controls (Table 2). MAMC and MAMA were comparable in both the groups.

All anthropometric parameters of patients with active disease were lower than those in remission, and those in healthy controls. TSF and MAFA of patients in remission were lower compared with those for healthy controls. All the remaining anthropometric parameters were comparable between the patients in remission and healthy controls (Table 3).

A gender-wise analysis revealed that only TSF and MAFA were lower in male patients compared with those in healthy male controls. In female patients, weight, BMI, TSF, and MAFA were all lower compared with healthy female controls. Women had a higher fat mass (as measured by TSF and MAFA) than men in patients as well as healthy controls (Table 2).

**Dietary intake**

There was no difference in the mean daily intake of macronutrients (energy, protein, carbohydrates and fat) and in the percentage calorie contribution from proteins, carbohydrates and fat between the patients and the healthy controls. However, there was a difference (p=0.0028) in the percent calorie fulfillment between the patients and the controls as per the recommended dietary allowance considering the injury factor and the activity factor (Table 2).

A gender-wise analysis revealed that the intake of all macronutrients and the percentage calories from protein, carbohydrates and fat were comparable between male patients and healthy controls. However, among women, patients had a lower intake of proteins and carbohydrates compared with controls.
The mean daily intake of macronutrients of patients in both the remission and active phases of the disease was similar to that of healthy controls. But there was a significant \((p=0.0003)\) difference in the percentage fulfillment of energy requirement between the active phase of the disease and healthy controls (Table 3).

Table 4 shows the biochemical parameters between patients in the active and remission phases of the disease. Hemoglobin, total protein, albumin and serum calcium all were significantly \((p<0.0001)\) lower in patients with active disease compared with those in remission.

Considering all the five parameters \((%IBW, \text{BMI, } \%\text{TSF, } \%\text{MUAC, } \%\text{MAMC})\) individually, the prevalence of malnutrition was more in the active phase than in the remission phase. Overall, considering patients with \(\geq 3\) parameters abnormal as malnourished, 52.6% of patients were found malnourished; 82.8% of patients with active disease and 38.9% in remission were malnourished (OR 7.5 [95% CI 2.8 – 20.4]; Table 5).

**Discussion**

We found that malnutrition was present in almost half of patients with \(\text{CD}\), and in 82.8% and 38.9% of patients in the active and remission phases, respectively.

Anthropometric measurements are a simple, reproducible and convenient mode of assessment of nutritional status, and help to identify patients with both clinical and biochemical features of malnutrition.\(^{15}\)

Approximately 20%–85% of patients with \(\text{CD}\) have impaired nutritional status.\(^{14}\) Underweight has been reported to be 65%–75% in patients with \(\text{CD}\); however, most studies have included patients with high disease activity.\(^{16–19}\) Our results are in accordance with these data. Patients with \(\text{CD}\) have significantly low BMI, TSF and MUAC compared with healthy controls.\(^{20}\) reimund et al have reported malnutrition in 45% of patients where two or more parameters were below the 15th percentile of normal values.\(^{1}\)

In our study, all anthropometric parameters were lower in patients with active disease when compared with those in remission. Except for fat mass, the remaining parameters were comparable between patients in remission and healthy controls. Jahnens et al\(^{21}\) had reported similar findings. Capristo et al\(^{21}\) reported a lower weight and BMI in the remission phase of \(\text{CD}\) compared with healthy controls. We also found that the fat mass as measured by TSF and MAFA was different, and muscle compartment as estimated by MAMC and MAMA was similar, between the patients and healthy controls. Also, patients in remission had lower TSF and MAFA values compared with

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**Table 3: Comparison of anthropometric and dietary parameters between patients in remission and active phases, and healthy controls**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Remission (n=77)</th>
<th>Active Disease (n=35)</th>
<th>p value</th>
<th>Healthy control (n=80)</th>
<th>p value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Height (cm)</td>
<td>160.9 (8.6)</td>
<td>160.6 (9.1)</td>
<td>0.888</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Weight (kg)</td>
<td>54.4 (14.7)</td>
<td>45.2 (9.2)</td>
<td>0.0000</td>
<td></td>
<td></td>
</tr>
<tr>
<td>BMI (kg/m(^2))</td>
<td>21.2 (5.0)</td>
<td>17.4 (2.7)</td>
<td>0.0000</td>
<td></td>
<td></td>
</tr>
<tr>
<td>MUAC (cm)</td>
<td>25.7 (4.8)</td>
<td>21.8 (3.5)</td>
<td>0.0000</td>
<td></td>
<td></td>
</tr>
<tr>
<td>TSF (mm)</td>
<td>10.4 (2.8–71)</td>
<td>6.7 (3.5–36)</td>
<td>0.014</td>
<td></td>
<td></td>
</tr>
<tr>
<td>MAMC (cm)</td>
<td>21.3 (3.7)</td>
<td>19.0 (2.7)</td>
<td>0.001</td>
<td></td>
<td></td>
</tr>
<tr>
<td>MAMA (cm(^2))</td>
<td>3718 (912–9820)</td>
<td>2941 (1462–4453)</td>
<td>0.001</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Energy (kcal)</td>
<td>1816 (675–3350)</td>
<td>1607 (720–2851)</td>
<td>0.001</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Protein (g)</td>
<td>53 (21–142)</td>
<td>50 (22–92)</td>
<td>0.110</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Carbohydrates (g)</td>
<td>282.1 (98.7)</td>
<td>249.1 (86.0)</td>
<td>0.02</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fat (g)</td>
<td>48 (19–127)</td>
<td>49 (9–80)</td>
<td>0.836</td>
<td></td>
<td></td>
</tr>
<tr>
<td>% Fat calories</td>
<td>25.1 (6.4)</td>
<td>26.2 (7.9)</td>
<td>0.300</td>
<td></td>
<td></td>
</tr>
<tr>
<td>% Carbohydrate</td>
<td>61.6 (7.2)</td>
<td>60.5 (7.9)</td>
<td>0.214</td>
<td></td>
<td></td>
</tr>
<tr>
<td>% Protein calories</td>
<td>12.4 (1.6)</td>
<td>12.6 (1.8)</td>
<td>0.119</td>
<td></td>
<td></td>
</tr>
<tr>
<td>% Energy fulfillment</td>
<td>93.1 (25.4)</td>
<td>80.8 (19.9)</td>
<td>0.000</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Values are expressed as mean (SD); TSF, MAMA, MAFA, energy, protein and fat are expressed as median (range).
healthy controls. Our findings were in line with those of previous studies,\textsuperscript{22-25} which reported lower fat mass in patients in remission compared with that in controls, but no difference was seen in fat free mass (FFM) between the patients and healthy controls.

Our findings also suggest that women had a higher fat mass than men, both in patients and controls, but TSF and MAFA were lower in patients compared with healthy controls. Other studies\textsuperscript{22,26} have reported a lower fat mass only in men. Contrary to this, Sentongo \textit{et al}\textsuperscript{27} reported a normal fat store, but a lower FFM in both genders compared with that in controls.

We are unable to explain the preserved muscle mass and reduced fat mass in these patients. Some studies have tried to explain this by an increased utilization of lipids as fuel substrates.\textsuperscript{28} It is hypothesized that patients with CD have a preferential lipid oxidation and reduced lipid stores. All the same, the increased requirement with a concomitant low calorie intake corroborates this hypothesis.

We found no difference in caloric intake of patients compared with that of healthy controls, as was found in previous studies.\textsuperscript{22,25,29} Geerling \textit{et al}\textsuperscript{22} reported that their patients with CD took significantly higher carbohydrate (energy\%) as compared with healthy controls. In spite of a similar intake of diet, our patients as a whole group and particularly with active disease did not fulfill their increased energy requirement. Somewhat similar observations reported earlier showed that dietary intake of patients with IBD seems to be adequate, but it may not be sufficient for the increased needs of those with CD.\textsuperscript{15}

Patients with CD have a reduced intake of food probably due to anorexia, depressed mood or owing to medical advice. However, our patients with active disease appeared to eat as much as those in remission and healthy controls. This was probably because they had a CDAI score in the range 150–250, which did not influence their dietary intake. In spite of ‘normal’ energy and protein intake, patients with CD, particularly those in the active phase, lose weight and have poor nutritional status. This is because of increased energy requirements coupled with active inflammation.

Our male patients were eating quite well, just as were healthy male controls, but the female patients seemed to be starving as they showed a decreased energy, protein and carbohydrate intake compared with healthy females.

We conclude that patients with CD in the active phase of the disease are severely malnourished, and that malnutrition is more prevalent among women. The important cause of malnutrition is inadequate intake to fulfill the increased energy demands. We suggest that patients with CD need nutritional counseling right from the beginning, which can prevent them from developing overt malnutrition due to active disease.

\textbf{References}


2. Geerling BJ, Smook AB, Stockbrugger RW, Brunner RJ. Comprehensive nutritional status in patients with long-standing

\begin{table}
\centering
\begin{tabular}{llllll}
\hline Parameter & Remission & Active & \textit{p} value & Odds ratio (95\% CI) \\
\hline
\%IBW & & & & & \\
Normal & 39 (50.6\%) & 8 (22.8\%) & 0.006 & 3.4 (1.39, 8.57) \\
Malnourished* & 38 (49.3\%) & 27 (77.1\%) & & \\
\hline
BMI & & & & & \\
Normal & 53 (68.8\%) & 12 (34.2\%) & 0.001 & 4.23 (1.8, 9.88) \\
Malnourished & 24 (31.1\%) & 23 (65.7\%) & & \\
\hline
\%MUAC & & & & & \\
Normal & 50 (64.9\%) & 9 (25.7\%) & 0.000 & 5.34 (2.19, 13.0) \\
Malnourished & 27 (35.0\%) & 26 (74.2\%) & & \\
\hline
\%TSF & & & & & \\
Normal & 34 (44.1\%) & 5 (14.2\%) & 0.002 & 4.7 (1.66, 13.5) \\
Malnourished & 43 (55.8\%) & 30 (85.7\%) & & \\
\hline
\%MAMC & & & & & \\
Normal & 34 (44.1\%) & 4 (11.4\%) & 0.001 & 6.12 (1.9, 19.0) \\
Malnourished & 43 (55.8\%) & 31 (88.5\%) & & \\
\hline
Nutritional Status & & & & & \\
Normal & 47 (61.0\%) & 6 (17.1\%) & 0.000 & 7.5 (2.8, 20.4) \\
Malnourished & 30 (38.9\%) & 29 (82.8\%) & & \\
\hline
\end{tabular}
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* Patients with \geq 3 parameters abnormal were defined as malnourished

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