

Nutrition, malnutrition and dietary interventions in inflammatory bowel disease

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Summary. Inflammatory Bowel Disease (IBD), which includes both Crohn's Disease (CD) and Ulcerative Colitis (UC), is a chronic idiopathic inflammatory disorder affecting the gastrointestinal tract. Diet, as a source of luminal antigens, is thought to be an important factor in the pathogenesis of IBD. Often the nutritional status of patients is significantly compromised, particularly in CD. Several factors, including drug-nutrient interactions, disease location, symptoms, and dietary restrictions can lead to protein energy malnutrition and specific nutritional deficiencies. Solid evidence regarding the accountability of certain dietary components in the etiology of IBD are lacking. With regard to malnutrition, its consequences are growth failure, weight loss, bone disease, and/or micronutrient deficiencies, although micronutrient deficiency in IBD in most cases does not tend to have any evident clinical manifestation, except with regard to iron, folic acid, and vitamin B. Nutritional supplementation is essential for patients with evidence of malnutrition to increase calorie and protein intake. Nutritional supplementation can also have efficacy in the induction and maintenance of remission in adults with CD, however it does not replace other treatments. Aim of this review is to discuss the role of nutrition and nutrients' deficiencies in the clinical setting of IBD, and to analyze efficacy and safety of the dietary interventions in patients with IBD.

Key words: Nutrition, malnutrition, diet, inflammatory bowel disease, IBD, crohn's disease, ulcerative colitis

«NUTRIZIONE, MALNUTRIZIONE E REGIME DIETETICO NELLE MALATTIE INFIAMMATORIE INTESTINALI»

Riassunto. Le Malattie infiammatorie intestinali (IBD), che comprendono sia la malattia di Crohn (CD) sia la Colite ulcerosa (UC), sono delle malattie infiammatorie croniche idiopatiche che colpiscono il tratto gastrointestinale. Si pensa che la dieta, in quanto fonte di antigeni luminali, sia un fattore importante nella patogenesi delle IBD. Lo stato nutrizionale di pazienti spesso risulta essere significativamente compromesso, specie nella CD. Diversi fattori, tra cui le interazioni tra farmaci e nutrienti, la localizzazione della malattia, i sintomi e le restrizioni dietetiche, possono portare a malnutrizione sia proteica che energetica e a specifiche carenze nutrizionali. Solide evidenze sussistono per quanto riguarda la responsabilità della carenza di alcuni componenti della dieta nell'eziologia delle IBD. Le conseguenze della malnutrizione sono la mancata crescita, la perdita di peso, alterazioni a livello osseo, e le carenze di micronutrienti; anche se la carenza di micronutrienti nelle IBD non

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tendono ad avere, nella maggior parte dei casi, alcuna manifestazione clinica evidente, tranne che per quanto riguarda il ferro, l'acido folico e la vitamina B. Una supplementazione nutrizionale è fondamentale per i pazienti con evidenza di malnutrizione per aumentare l'apporto di calorie e proteine. Una supplementazione nutrizionale può anche avere efficacia nella induzione e nel mantenimento della remissione in pazienti adulti affetti da CD, tuttavia tale supplementazione non è capace di sostituirsi ad altri trattamenti. Scopo di questa review è quello di discutere il ruolo della nutrizione e delle sue carenze nell'ambito clinico delle IBD, e di analizzare l'efficacia e la sicurezza degli interventi dietetici nei pazienti con IBD.

Parole chiave: Nutrizione, malnutrizione, dieta, malattie infiammatorie croniche dell'intestino, MICI, malattia di Crohn, colite ulcerosa

Introduction

Inflammatory Bowel Disease (IBD), which includes both Crohn's Disease (CD) and Ulcerative Colitis (UC), is a chronic idiopathic inflammatory disorder affecting the gastrointestinal tract. (1). CD and UC affect more than 1 million people in the United States, with thousands of new diagnoses annually (2,3). The natural history of CD and UC is characterized by repeated episodes of inflammation and ulceration of the bowel. This results in complications implying a worse quality of life and significant healthcare costs, due to hospitalization, surgery and an escalation of therapy (4-6).

IBD lead to to symptoms of pain, nausea, fever, and diarrhoea (7). These symptoms can result in loss of appetite, reduced nutrient intake, altered nutrient metabolism, and ultimately impaired nutritional status, as a result of the release of cytokines such as IL-1, IL-6, and tumor necrosis factor.

Diet, as a source of luminal antigens, is thought to be an important factor in the pathogenesis of IBD, but whether antibodies against dietary antigens play a primary role in IBD aetiology or are secondary to intestinal inflammation is yet to be established. In such endeavour, epidemiologic observations may become valuable for identifying dietary factors, which are involved in the aggravation or otherwise promote disease remission.

In IBD, nutritional status of patients is significantly compromised, particularly in CD. Several factors, including drug-nutrient interactions, disease location, symptoms, and dietary restrictions can lead to protein energy malnutrition and specific nutritional deficiencies.

It is estimated that up to 85% of hospitalized IBD patients have protein energy malnutrition, based on abnormal anthropometric and biochemical parameters (8,9).

As Crohn's disease can occur anywhere in gastrointestinal tract, from mouth to anus (80% of cases in the terminal ileum), it is associated with greater nutritional insult than UC, which involves only the colon and rectum.

Currently various dietary interventions or supplements are available for such patients (10,11).

Aim of this review is to discuss the role of nutrition and nutrients' deficiencies in the clinical setting of IBD, and to analyze efficacy and safety of the dietary interventions in patients with IBD.

Nutrition and pathogenesis of inflammatory bowel disease

IBD results from the interaction of three essential cofactors: genetic susceptibility, environment and the immune response of the individual (12).

The ultimate causes of IBD have not yet been identified, but epidemiological studies show differences in the rate of IBD in terms of age and onset, race and geographical areas (13,14). The existence of environmental factors is therefore suggested, which are capable of substantially altering the appearance of CD and UC (15).

Various dietary and nutritional factors have been suggested as being significant etiological factors both for CD and UC.

Several authors have reported that fats (16,17) as well as refined sugar (16,18-23) increased the risk of

developing IBD, while fruits (19,24,25) and vegetables (16,19,24,25) decreased this risk.

With regard to CD, in a case-control study, performed by Sakamoto and coworkers, CD patients and normal individuals were given a semiquantitative food frequency questionnaire to estimate the pre-illness intake of food groups and nutrients (17). The investigators found that intakes of total fat, monounsaturated fatty acids, and PUFAs (both n-3 and n-6) were positively associated with IBD risk. Perhaps the relationship between a high fat diet and IBD was thought to be related to the digestive process associated with these diets. Furthermore, various studies have shown that new consumption patterns, such as fast food, could be linked to an increased risk in the development of CD and UC (26,27). In addition, the consumption of large amounts of monounsaturated and polyunsaturated fats are both associated with a higher risk of UC (28,29).

The further observation that the Eskimos in Greenland, consumers of large quantities of n-3 polyunsaturated fatty acids (PUFAs) deriving from fish oils, had a low prevalence of IBD (30,31) led to the study of the anti-inflammatory properties of n-3 PUFAs (32), in comparison with pro-inflammatory n-6 PUFAs. The latter have been clearly implicated in the origin of IBD, given that they affect the arachidonic acid metabolism by increasing the production of leukotriene B₄, with pro-inflammatory action. These discoveries have opened up new windows of action regarding the ability of lipids in the diet to regulate inflammatory processes in different diseases, as they are the fundamental component of cell membranes, including those of lymphocytes, which orchestrate immune system responses (33).

With regard to sugars, previous studies have indicated the high consumption levels of sugar and refined carbohydrates in patients with IBD (34,35) to the extent that they are now considered a risk factor for CD (36-38) and UC (39-41). Conversely, the consumption of citrus fruit, fruit juices and vegetables could lower the risk (42) of the development of both diseases (43-45), and a study has also showed an inverse relationship between the consumption of bran and the onset of CD (46).

Up to now, it has been impossible to determine whether the potentially protective effect is due to the action of the fiber or to other micronutrients contained

in fruit and vegetables. The utility of low refined carbohydrate diets in the treatment of CD has been suggested by several authors, although extensive clinical trials have not confirmed the benefits of this measure (47).

Scanty data are available about the role of proteins and calories in diet in the pathogenesis of IBD, even if some studies have suggested that the intake of proteins (29, 48) and calories (29) might be higher in patients with IBD compared to controls.

To date, solid evidence regarding the accountability of certain dietary components in the etiology of IBD are lacking, although the data discussed above allow to us to consider that the changes in the composition and characteristics of the diet which typifies modern life have been accompanied by substantial changes in the epidemiology of IBD in developed countries.

Malnutrition in inflammatory bowel disease

In both Crohn's disease and ulcerative colitis, malnutrition is the result of numerous pathogenic factors including anorexia, malabsorption, altered metabolism, and fluid and electrolyte loss, as well as side effects of medications (49).

Nutritional deficiencies occur very early in the disease process and are often clinically apparent at the time of diagnosis. The pattern and severity of malnutrition in IBD depends on the duration, activity and extent of the disease, with significant differences having been described between CD and UC, given that the involvement of the small intestine is accompanied by a higher incidence of protein-calorie malnutrition and deficiencies in specific nutrients (50).

Jahnsen, and coworkers, emphasizes differences in nutritional status between ulcerative colitis and Crohn's disease, and the need to evaluate these patients separately (51).

Furthermore, CD presents considerable chronic deficiencies, whereas in UC, the nutritional status tends to be more preserved, although during the flares of activity of the disease and in cases of hospitalization, the deficiencies tend to be significant (52).

Consequences of malnutrition are growth failure, weight loss, bone disease, and/or micronutrient deficiencies; the latter will be reviewed here, considering

however that although micronutrient deficiency in IBD is common, in most cases it does not tend to have any evident clinical manifestation, except with regard to iron, folic acid, and vitamin B12 (15).

Vitamins deficiency

Folate deficiency, which may lead to the development of anemia in patients with IBD, was frequently observed in adults with IBD (20-60%, according to previous series), and but it appear less frequent in studies from the last decade (53,54). This historical difference could reflect changes in medical therapy (eg, less use of sulfasalazine) and/or higher levels of folate intake through supplements or foods. In fact treatment with sulfasalazine may exacerbate folate deficiency, since the drug's sulfa moiety can bind folate in the gut lumen, leaving it unavailable for absorption. This is not true for other aminosalicylates, such as mesalamine. Treatment with methotrexate (a folic acid antagonist) can also contribute to folate deficiency. In modern series of children with newly diagnosed IBD, folate concentrations were normal or higher than those of controls (55,56).

Interestingly, the absence of folic acid has been related to the increased risk of colitis-associated carcinogenesis, as well as it is also linked to the increased incidence of arterial and venous thromboembolic events observed in CD and UC (15).

Vitamin B12 deficiency, which also can contribute to the increased incidence of anemia seen in patients with IBD, has been reported in about 20 percent of adult and pediatric patients with CD (57,58) although it appears to be rare in children with newly diagnosed IBD (56). Factors leading to vitamin B12 deficiency include disease or resection of the terminal ileum, gastritis, and bacterial overgrowth. With regard to niacin, Low plasma concentrations of this vitamin are common among patients with CD, but clinically apparent disease is rare.

Fat-soluble vitamin deficiency (vitamins A, D, E, and K) may occur in patients with CD when complicated by fat malabsorption, which can be caused by bile acid deficiency due to terminal ileal disease or resection (because bile acids undergo active resorption in the terminal ileum), or by the use of drugs, such as cholestyramine, that bind bile acids.

Vitamin A (retinol) deficiency has been reported in IBD in about 5 percent of patients, which may develop impaired dark adaptation. However, low serum levels of vitamin A do not always indicate clinical deficiency because this finding can be caused by hypoproteinemia (59).

Vitamin D deficiency (<10 ng/mL) is common in IBD patients, with an incidence reported to be up to 25% in adults, and up to 36% in children. (60-63). Environmental factors, such as diet and sun exposure, as well as factors related to the IBD itself (malabsorption and anorexia) may lead to deficiency of this vitamin.

Individuals with malabsorption or established vitamin D deficiency may require higher doses of vitamin D to reach target levels of serum 25-hydroxyvitamin D. In such patients, the adequacy of the calcium and vitamin D supplementation should be confirmed by measurements of serum 25-hydroxyvitamin D and, according some authors, of PTH. As for vitamin D, Vitamin K deficiency may be a contributor to bone disease in individuals with IBD because this vitamin is a cofactor in the carboxylation of osteocalcin, a protein essential for calcium binding to bone (64,65) even if this association is based on indirect evidence.

Vitamin E were proved to be lower in adult patients with IBD as compared with healthy controls but this was not the case in a series in children while deficient serum vitamin E levels (eg, <0.5 mg/dL) are unusual (66,67). It has been suggested that depletion of vitamin E and other antioxidant vitamins (such as retinol) may contribute to the pathogenesis of IBD, but such pathways have not been yet established.

Minerals deficiency

Iron deficiency, affecting up to 90% of IBD adult patients, is probably the primary cause of the anemia that affects 16 percent of outpatients and up to 70 percent of inpatients (53,68). Iron deficiency in IBD is usually caused by chronic blood loss. The resulting anemia is compounded by suppression of erythropoietin production and alteration of iron metabolism caused by proinflammatory cytokines, reactive oxygen metabolites, and nitric oxide, a condition called the anemia of chronic inflammation (anemia of chronic disease).

Patients with IBD should be screened for iron deficiency periodically by measuring hemoglobin, ferritin, and C-reactive protein (CRP). However, as serum ferritin levels increase in the setting of inflammation, patients with active IBD or acute infection may have a “falsely” normal ferritin concentration. In patients without biochemical or clinical evidence of inflammation, iron deficiency is indicated by a serum ferritin <30 mcg/L. In the presence of inflammation (eg, with an elevated CRP), serum ferritin levels below 100 mcg/L should be considered abnormal.

In patients with mild to moderate IBD disease activity who have no known sensitivity to oral iron, we suggest supplementation with oral iron. In patients with severe IBD disease activity, we suggest parenteral iron supplementation to avoid worsening gastrointestinal symptoms, since these patients are already particularly fragile. In adults, other indications for parenteral iron supplementation include hemoglobin less than 10 grams per dL, intolerance, or inadequate response to oral iron, concomitant therapy with an erythropoietic agent, or patient preference (69).

Up to 65 percent of patients with CD have zinc deficiency (56,70,71). However, serum zinc levels vary with albumin and correlate poorly with total body zinc stores; clinically significant zinc deficiency is probably much less common.

Excessive losses of zinc may be observed in patients with ostomies, fistulas, and profuse diarrhea, or in those with prolonged parenteral nutrition unless trace minerals are included. The skin changes are the most distinctive manifestations of zinc deficiency, which consist of dry scaly eczematous plaques, often on the face and anogenital area, often resembling psoriasis.

Zinc is a vital component for the healing of wounds and its deficiency should be considered in the case of recurrent fistulous disease (72,73).

In addition, zinc is a co-factor of superoxide dismutase, which protects against cell damage caused by free radicals. Symptomatic zinc deficiency in patients with IBD is treated with oral or parenteral zinc at replacement doses.

Approximately 13 percent of adults with CD malabsorbs calcium (74), as a result of the binding of calcium to undigested fats in the intestinal lumen, of loss

of the ileum leading to vitamin D deficiency, and possibly of genetic factors and the effects of inflammatory cytokines. In addition, patients may have inadequate intake of calcium in their diets (54). Negative calcium balance is one of several factors contributing to bone disease in IBD patients, together with glucocorticoid treatment and pubertal delay. All patients with IBD should be monitored for the right intake of calcium (1300 mg daily in adolescents and 1000 to 1500 mg daily in adults) and vitamin D (600 International Units daily).

Phosphate deficiency may occur in patients with chronic diarrhea because of malabsorption of phosphate and vitamin D, but rarely with the only poor intake. In malnourished patients, sudden increases in nutrition (refeeding syndrome) can cause acute hypophosphatemia. As a consequence, malnourished patients with CD and chronic diarrhea are at risk for hypophosphatemia and require close monitoring and phosphate replacement.

Selenium is a co-factor of glutathione peroxidase (75). Deficient levels of selenium are more common among patients with CD who have undergone small bowel resection of >200 cm and those receiving exclusive enteral nutrition (76-78).

Copper, normally required for iron absorption, is an essential trace element used in many enzyme complexes, and its deficiency abnormally-formed hair, depigmentation of the skin, and microcytic anemia. The neurologic manifestations include ataxia, neuropathy, and cognitive deficits that can mimic vitamin B12 deficiency. Most adults and children with IBD do not demonstrate copper deficiency; conversely, some series report relatively high copper levels (70,78-80,81). However, increased losses are observed in those with profuse diarrhea, fistulas, or ostomies, or those maintained on parenteral nutrition without mineral supplements (82,83).

Magnesium deficiency, which may contribute to osteopenia in patients with IBD, may result from decreased oral intake, malabsorption, increased intestinal losses, or low concentrations of magnesium in a formula used for enteral nutrition (84-86). Mild or chronic deficiencies can be supplemented orally with magnesium chloride.

In conclusion, to assess exhaustively the nutritional status of IBD patients, hemoglobin, albumin, vitamin D, and vitamin B12 in patients with Crohn's disease affecting the terminal ileum should be monitored. Measurement of serum concentrations of folate, vitamins A and E, parathyroid hormone, prothrombin time, magnesium, calcium, phosphorus and zinc may also be indicated based upon disease severity and location.

Dietary interventions in inflammatory bowel disease

Elimination Diet

The use of an exclusion diet trial should eliminate the possibility of an adverse food reaction. In fact, many patients can identify foods that they believe may precipitate or worsen their disease and it is reasonable for them to avoid such foods. Using an elimination diet to identify at-risk foods may decrease the possibility of a "flare" of IBD.

In a multicentre trial (87), 78 patients who had achieved remission with elemental diet were randomly assigned to corticosteroids ($n = 38$) or diet ($n = 40$). Median remission time was 3.8 months in the corticosteroid group vs 7.5 months in the diet group, and relapse rates at 2 years were 79% in the corticosteroid group vs 62% in the diet group, significantly favouring the diet for maintenance of remission. Food intolerance was mainly to cereals, dairy products and yeast (87).

In the study performed by Jones and coworkers, the authors evaluated the use of an elimination diet versus an unrefined carbohydrate, fiber-rich diet in patients with CD who were currently in remission. Relapse rates at six months were 100 percent in the unrefined carbohydrate, fiber-rich diet versus 30 percent on the elimination diet (88).

In the study performed by Giaffer and coworkers, Twenty-seven patients with established Crohn's disease who attained clinical remission after four weeks of enteral feeding were followed prospectively for up to 36 months. Twenty of these were willing to be tested for specific food intolerance using a pre-defined dietary elimination protocol; the others continued on a normal unrestricted diet. Eighteen patients (67%) have

since relapsed; 89% of the relapse occurred within the first 6 months. Of the 14 patients who completed the process of dietary testing, 5 could not identify any trigger foods; the remaining 9 were maintained on exclusion diets, 3 of whom relapsed early. Of the 11 taking a normal diet, 9 relapsed. Disease duration, previous intestinal resection or prior steroid therapy did not affect the relapse rate (89).

Finally, lactose elimination can be particularly beneficial. Lactose intolerance is frequently noted in patients with ulcerative colitis. A lactose hydrogen breath test, performed in this context, may be helpful to confirm the diagnosis. To avoid the risk of bone loss, Calcium supplementation should be maintained in such patients.

Probiotics

In recent years, we have increased our knowledge of the immunoregulatory function of intestinal microflora and its possible participation in the physiopathology of IBD (90,91). Alteration of the composition and function of intestinal microbiota could lead to increased stimulation of the intestinal immune system, epithelial dysfunction and greater permeability of the mucosa, and accordingly, the correct characterization of the components of these microflora and the definition of their functions are vital in order to consider probiotic treatment for IBD (92,93). Probiotics have shown to be as effective as mesalazine in preventing relapses in patients with UC (94) and in the treatment of pouchitis (95). On the other hand, there have not been convincing data on the efficacy of various probiotics for the prevention of relapse in CD (96).

Dietary fiber and prebiotics

In a retrospective study (97), 32 patients with CD, treated with a fibre-rich, unrefined-carbohydrate diet had a reduced rate of hospital admission and surgeries as compared with 32 patients in the non-diet-treated group. The outcome suggested that treatment with a fibre-rich, unrefined-carbohydrate diet has a favourable effect on the clinical course of CD. Germinated barley foodstuff (GBF) is a prebiotic that effectively increases luminal butyrate production by stimulating

the growth of protective bacteria. Several open-label trials have reported that oral GBF reduced clinical activity (98,99), and prolonged remission time in patients with UC (100). However, further large clinical trials are necessary to validate the efficacy of dietary fibre as prebiotics in the management of IBD.

Omega-3 polyunsaturated fatty acids (PUFAs)

The beneficial effect of n-3 PUFAs in Crohn's disease patients with high C-reactive protein and erythrocyte sedimentation rate is supported by a supplement containing fish oil and antioxidants. In a randomized placebo-controlled trial evaluating the beneficial effect of n-3 PUFAs in 31 CD patients receiving fish oil (101), greater proportions of docosahexaenoic acid and eicosapentanoic acid were incorporated into peripheral mononuclear cells as compared with arachidonic acid, and these patients exhibited lower production of both interferon-gamma, and prostaglandin-E₂. Another study, evaluating the role of oral vitamins (102), found that supplementation with vitamins C and E decreased oxidative stress, as estimated by breath pentane and plasma lipid peroxides, in 51 CD patients as compared with normal individuals. However, neither of these studies found that treatment reduced disease activity. Two large placebo-controlled trials in CD (103) and systematic reviews of clinical trials in patients with UC and CD (104,105) found that oral ingested fish oil supplementation, while safe, is ineffective for inducing or maintaining remission in either UC or CD.

Enteral nutrition

In a systematic review performed by Zachos and coworkers (106), corticosteroids were proved to be more effective than enteral nutrition in inducing remission in active CD. Although corticosteroids are clearly superior to enteral nutrition, it should be highlighted that the response rate to enteral nutrition is much greater than one would expect with placebo, probably indicating that enteral nutrition does have a role to play in the treatment of CD.

It is important consider that enteral nutrition presents with fewer side effects than corticosteroids. The

therapeutic mechanisms of enteral nutrition in CD remain unknown.

Initially it was suggested that the antigenicity of dietary protein would trigger bowel inflammation. However, the previously mentioned meta-analysis (106) failed to identify differences in remission rates with amino acid, peptide, or whole protein based diets. Fat composition has seldom been taken into account when comparing the effect of diet in CD.

The first randomized, controlled trial in which elemental diets containing different fat percentages were used to treat patients with active Crohn's disease (107) was performed in 2003 by Bamba and coworkers. In this study, patients received one of three doses of fat in an elemental dietary supplement for 4 weeks: 10 patients received a low fat diet (3.06 g/day), 10 patients received a medium fat diet (16.56 g/day), and eight patients received a high fat diet (30.06 g/day). The additional fat was composed of long chain fatty acids. It was showed that C-reactive protein and erythrocyte sedimentation rate decreased in the low fat group, whereas the values of these parameters in the medium and high fat groups fluctuated during the study. The remission rates after 4 weeks were 80%, 40%, and 25% for patients in the low fat, medium fat, and high fat groups, respectively. In another study (108), two enteral diets with identical macronutrient distribution but different qualitative fat composition were compared. The oral diet consisted of oleic acid, linoleic acid, or prednisone, and was administered to patients with active CD for 4 weeks. Twenty per cent of patients taking the oleic acid went into remission, whereas 52% of patients taking the linoleic acid went into remission; the remission rate for the steroid group was 79%. These data show how the type of dietary fat may be of importance to the therapeutic effect of enteral nutrition in CD.

immunomodulatory properties. With regard to the pediatric setting, an open trial evaluated an enteral formula produced with whole milk that is rich in transforming growth factor- β 2 in 29 pediatric patients (109). Clinical remission occurred after consuming this product for 8 weeks as the sole source of nutrition in 79% of the study participants. Patients with ileal disease were noted to have the greatest improvement.

In a retrospective study of 45 adults with CD, the aforementioned enteral formula induced remission in

nearly half of the patients studied (110). A majority of these patients were resistant or intolerant to immunosuppressants. The efficacy of the product was noted to be greater in patients with acute inflammation, characterized by elevated C-reactive protein at treatment initiation.

Application of specific nutrients has also been studied using the parenteral route of administration. Studies in animal models of IBD suggested that glutamine enriched enteral nutrition decreases bacterial translocation and stimulates mucosal secretion of immunoglobulin A (111).

Finally, although most trials using enteral nutrition have been performed in patients with active disease, a study (112) has evaluated the role of enteral nutrition in the prevention of clinical relapse after surgery for CD. In this report the consumption of at least 1200 kcal/day of enteral nutrition was associated with a lower rate of disease relapse, especially in patients who underwent surgery for penetrating disease. Perhaps this mode of treatment should be considered in a selected group of patients with aggressive disease.

Finally, limited data exist on enteral nutritional therapy in patients with UC. One prospective randomized trial compared enteral nutrition with total parenteral nutrition as an adjunct therapy in severe UC patients on glucocorticoid therapy (113). Remission rates were similar in the two groups.

Total parenteral nutrition

Parenteral nutrition can provide nutrition to patients with active disease and intolerance to enteral feedings, presence of obstruction and/or stricture, presence of a distal fistula with inability to feed beyond site, or with severe short bowel syndrome (approximately less than 150 cm of small bowel remaining).

Use of PN has not been found to be effective as primary therapy in CD or UC (113). The use of perioperative PN has not been carefully studied in IBD and may be used for severely malnourished patients who meet the above criteria. The American Gastroenterological Association technical review of six trials concluded that TPN provided no benefit in the routine treatment of IBD and may be equivalent to enteral

nutrition when treating patients with active CD of the small bowel (114).

Conclusions

Nutrition plays an important role in the pathogenesis and treatment of CD and UC. Ongoing nutrition assessment and a multidisciplinary approach are useful tools to manage IBD patients. Nutritional supplementation is essential for patients with evidence of malnutrition to increase calorie and protein intake. Nutritional supplementation can also have efficacy in the induction and maintenance of remission in adults with CD, however it does not replace other treatments.

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