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Diverticular Disease: Evidence for Dietary Intervention?

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A low-fiber diet is thought to be responsible for the rising trends in the incidence of diverticular disease and its complications. Furthermore, a high-fiber diet is thought to prevent the occurrence of symptoms in patients with diverticular disease. This review suggests that most of the evidence for a causal relationship is based on observational, uncontrolled studies, and that evidence from the only two randomized controlled trials conducted to test this hypothesis is inconsistent. Despite the limitations in the data, the fiber-diverticulosis hypothesis makes biologic sense, is based on sound epidemiologic data and fiber should be recommended until more valid studies are conducted.

DIVERTICULAR DISEASE: FIBER AS AN ETIOLOGIC FACTOR AND THERAPEUTIC AGENT

In a landmark paper entitled Diverticular Disease of the Colon: A deficiency disease of Western civilization published in the Lancet in 1971, Painter and Burkitt (1), hypothesized that diverticulosis coli appeared to be a deficiency disease caused by refining of carbohydrates and the removal of fiber from the diet. They noted that diverticular disease had only become a significant clinical problem in the 70 years before publication of their paper, and that as recently as 1916, it was not even mentioned in medical textbooks. They also noted that the incidence had risen dramatically, with approximately one-third to one-half of those over 40, and two-thirds of those over 80 years of age, having diverticula (1). Furthermore, the incidence was much higher in economically developed countries, where the diets were low in fiber, when compared to less developed countries. The biggest differences noted were between Western countries and Africa or Asia; countries that had recently become industrialized, demonstrating a rising, but intermediate

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incidence of diverticular disease (1). Since Painter and Burkitt published this landmark "hypothesis," various other researchers have examined the hypothesis and concluded that indeed there is an association between a low-fiber diet and diverticular disease and that a high-fiber diet/fiber supplementation is likely to prevent symptoms of diverticular disease. However, the evidence for this association is based largely on observational, epidemiologic studies and a few small clinical trials, with inconsistent results. This paper will review some of the studies that led to the acceptance of Painter and Burkitt's fiber-diverticular hypothesis.

EVIDENCE FROM POPULATION BASED, OBSERVATIONAL, ECOLOGIC STUDIES COMPARING NATIONAL TRENDS OF FIBER INTAKE AND TRENDS OF DIVERTICULAR DISEASE

Most of the original ecologic studies that have been used to support the association between declining fiber intake and diverticular disease were not originally designed to test this association, but were designed to independently examine either the change in dietary intake over time, or the change in disease incidence over time. Heller (2) used US food consumption data to determine crude fiber intake during seven time periods between 1909 and 1975. Crude fiber intake dropped 28% from 6.8 g/day in 1909 to 4.9 g/day in 1957 to 1959 and remained at the same level until 1975. Heller concluded that fiber intake had decreased coincidentally with increases in degenerative diseases. During the same period of time there was an increase in the incidence of diverticular disease (1). The diagnosis of diverticular disease in these studies was based either on necropsy series done on all patients or barium enema studies done on symptomatic patients. In summarizing these studies, Ohi, et al (3) states that the incidence of diverticular disease in Western countries increased from 5% to 10% from the beginning of the 20th century to the 1940s, and then 10% to 30% from the 1940s to the 1960s, and up to 50% in the 1970s. This increase trailed by 40 or so years the decline in fiber intake described by Heller, et al.

Ohi, et al then decided to compare available data on fiber intake trends among the Japanese to trends of diverticular disease in the same population. They used national data from the Japanese Basic Statistical Data on Supply and Demand of Foods to compute food consumption data from which dietary and crude fiber intakes were calculated for the years 1911 to 1935. The fiber intake from the period after the Second World War was based on a National Nutrition Survey, which has been published yearly since 1946. They identified a fairly rapid fall during the period from 1951–1955 to 1971–1975. This decline was a decade or two behind the decline seen in American diets. Ohi, et al then looked at changes in the incidence of diverticular disease by year in both America and Japan. They found that the incidence of colonic diverticulosis seemed to rise sharply around 1930 to 1950 in the United States and around 1970 to 1980 in Japan. These trends in diverticulosis appearance were similar to those seen with a decrease in fiber intake. They postulated that there was a dietary fiber intake threshold below which, the incidence of colonic diverticulosis rises sharply. Ohi, et al also noted differences in fiber intake and colonic diverticulosis among rural and urban Japanese populations. In addition, the Japanese tended to have right-sided disease as opposed to Americans who often have left sided disease. They concluded that with time the incidence of colonic diverticulosis among the Japanese would equal that seen among Americans.

Though these studies seem to suggest a causal relationship between dietary fiber and diverticular disease these data are subject to "ecologic fallacy," a danger that arises when population based national data is used to determine or imply individual risk. At best, these studies can be considered as hypothesis generating rather than hypothesis testing studies.

EVIDENCE FROM INDIVIDUAL, OBSERVATIONAL, CROSS-SECTIONAL STUDIES

Gear, et al (4) evaluated the association of fiber intake and asymptomatic diverticular disease among vegetarians and non-vegetarians. Vegetarians had a significantly higher mean fiber intake (41.5 g/day) when compared to non-vegetarians (21.4 g/day). In addition, diverticular disease was consistently found more frequently among non-vegetarians. For subjects greater

than 59 years, subjects with diverticular disease had a significantly lower mean intake of fiber than those without in both vegetarians and non-vegetarians. The major limitation of this study is that the risk factor (fiber intake) and the disease (diverticular disease) were measured at the same time. An important part of establishing disease causation requires a temporal relationship in which the hypothesized causative factor precedes the onset of disease. Gear, et al's study fails to demonstrate that a low-fiber intake or being a vegetarian came before the development of diverticular disease since it was impossible to determine when the subjects actually first developed diverticular disease. Despite its limitations, this study was an improvement over studies using population-based or national data in that the association was at an individual rather than at a population level.

EVIDENCE FROM OBSERVATIONAL, CASE-CONTROL STUDIES

Brodrib and Humphreys (5) conducted a case-control study in which they found that 40 British patients with symptomatic diverticular disease had a significantly lower usual crude fiber intake (2.6 g/day vs. 5.2 g/day) when compared to 80, age and sex-matched controls. Patients with diverticular disease also had a significantly higher prevalence of hemorrhoids, varicose veins, abdominal and hiatal hernias and gallstones. The second case-control study was conducted in Greece and compared the dietary intakes of 80 food items between 100 patients with symptomatic diverticular disease and 110 controls who did not have any abdominal symptoms or colonic diverticulosis (6). Patients had a significantly less consumption of vegetables and brown bread, potatoes and fruit, and a higher intake of meat, milk and milk products (6). They also noted that there was a 50-fold difference in the risk of diverticular disease between people who rarely consumed vegetables but had a high frequency of meat intake, and those who frequently consumed vegetables and rarely consumed meat (6).

Case control studies are subject to a "recall bias" in which patients with diverticular disease are likely to underestimate their fiber intake. In minimizing the role of recall bias, Brodrib and Humphreys (5) argued that patients in their study had neither changed their fiber intake, nor had they been advised to do so, and therefore, were not likely to have underestimated intakes. The intakes among controls were close to the usual British population intake of 4 to 8 g/day and were therefore unlikely to have been overestimated. Manousos, et al (6) cautioned that based on their findings, "fiber deficiency" may not have been the only etiologic factor, but that meat and milk intake were independent risk factors for diverticular disease.

EVIDENCE FROM OBSERVATIONAL, PROSPECTIVE, COHORT STUDIES

The best evidence for an association between diverticulosis and dietary fiber intake came from the Health Professions Follow-up study, a prospective study in which a cohort of 51,529 male U.S. health professionals, who were enrolled in 1986 and then asked questions about developing diverticular disease in 1990 and 1992 (7). Individual dietary intake data was collected at enrollment. The sample provided 188,252 person-years of follow-up in which 385 symptomatic cases were identified (7). There was a significant inverse association between diverticular disease and energy adjusted intakes of both crude and total dietary fiber (7). Fruit and vegetable intake, cellulose, hemicellulose, and lignin were inversely associated with the risk of symptomatic diverticular disease. Cereal fiber was not associated with diverticulosis. The association was stronger for cellulose, lignin and insoluble fiber. Aldoori, et al further found that insoluble fiber reduced the risk of diverticular disease by 37% (RR 0.63 CI 0.44 to 0.99) and that cellulose resulted in a 48% reduction (RR 0.52 CI 0.36 to 0.75) (8).

Furthermore, fiber reduced the risk of diverticular disease presenting with abdominal pain and change in bowel habits (RR 0.63 CI 0.40 to 0.99) while there was no significant reduction in those patients with symptoms of mainly bleeding or positive fecal occult blood (RR bleeding 0.61 CI 0.20 to 1.87 and RR for fecal occult blood 0.43 CI 0.17 to 1.10) (8).

The Health Professions Follow up study satisfies a number of conditions that are needed to support a

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causal relationship between fiber deficiency and diverticular disease. Fiber intake of individual participants was measured long before development of diverticular disease and the authors were able to calculate individual risk (7, 8) due to cellulose and insoluble fiber.

EVIDENCE FROM INTERVENTIONAL, UNCONTROLLED PROSPECTIVE TRIAL

In 1967 Painter, et al (9) recruited 70 patients with symptomatic diverticular disease and advised them to take a high-residue, low-sugar diet together with unprocessed bran enough to result in about one or two bowel movements a day. After an average of 22 months, 62 patients reported a relief in their symptoms with a normal bowel habit and relief of abdominal pain. Seven patients were unable to give up laxatives, eight could not tolerate the bran diet, and one required surgery, while none of the 62 patients who took the diet needed surgery. The average bran consumption was 12–14 g daily and ranged from 3g/day to 45g/day.

Broddrib and Humphreys treated the 40 patients who were part of the case-control study mentioned earlier (5) with 24g/day of wheat bran over a period of six months (10). No control group was employed. They report that 33 (out of 40) had a satisfactory clinical response with 60% of all symptoms being abolished and 23% being relieved. The transit times of patients with initial transit tines greater than 60 hours were reduced, while those with times less than 30 hours were increased (10). The major limitation of this study was lack of a control group with diverticular disease who did not receive the same therapy.

Hyland and Taylor (11) enrolled 100 patients who were admitted to a single hospital from 1971 to 1973 with symptoms of acute diverticulitis and no other explanation for their symptoms. At discharge from the hospital they started these patients on a high-fiber diet providing about 40 g of fiber per day. They then reviewed those patients five-to-seven years after admission and found that 91% of the patients on the high-fiber diet remained symptom free. They concluded that a high-fiber diet may be protective and prevent further complications.

Leahy, et al (12) evaluated 72 patients admitted to a United Kingdom hospital with symptoms of diverticular disease from 1972 to 1981. Fifty-six patients were enrolled in the study in which 43 patients were counseled on a high-fiber diet containing a minimum of 25 g fiber daily. They excluded patients with evidence of diverticulitis, complications of diverticulitis, or patients who were managed surgically. The remaining 13 were not counseled for unclear reasons. Follow-up was conducted in 1983 and included a dietary evaluation of fiber intake and determination of subsequent symptoms, complications and need for surgery. The patients were then divided into either a high-fiber (n = 31) or a low-fiber (n = 25) diet group depending on their fiber intake and compliance with the high-fiber diet recommendations during the follow-up period. There was a 72% compliance with recommendations. The patients on a high-fiber diet had a significantly lower incidence of diverticular disease symptoms and complications; they also required less surgery.

Though these studies seem to suggest that fiber reduced the incidence of symptoms and complications in patients given a high-fiber diet, the absence of a randomized control group greatly weakens the validity of these studies. However, these studies seem to support the biologic explanation for how fiber deficiency may result in diverticular disease. Brodribb and Humphreys (10) showed that fiber shortened stool transit times and Painter (9) showed that fiber normalized bowel habits. Most reviewers agree that decreased fiber intake results in less bulky stool and longer colonic stool transit times leading to stronger colonic contractions and higher intracolonic pressure. The chronic increase in colonic pressure is thought to result in hypertrophy of colonic wall muscle and formation of diverticula in the weaker regions of the colonic musculature (13,14).

EVIDENCE FROM RANDOMIZED CONTROLLED TRIALS

Brodribb, et al conducted the first double-blind-control trial of patients with symptomatic diverticular disease in 1977 (15). The diagnosis of symptomatic diverticular disease was based on a composite score of "dyspeptic symptoms," and "bowel dysfunction" symptoms in patients with radiologic evidence of diverticular disease. The symptoms were collected using a detailed symptom questionnaire, that the patients were

asked to complete at the beginning of the study. The 18 enrolled patients were randomly allocated either to a wheat crisp bread supplying 0.6 g of fiber daily or a bran crispbread containing 6.7 g of fiber daily. The patients were followed for three months and were interviewed monthly to determine compliance and to have them complete the enrollment questionnaire again. There was a highly significant reduction in the mean overall symptom score for the nine patients in the high-fiber group compared to controls. Though the high-fiber group experienced a significant decline in the pain score there were no significant differences in the dyspeptic and bowel dysfunction scores.

Another randomized-crossover-double-blind-controlled trial was conducted by Ornstein, et al also in the U.K. (16). Fifty-eight patients with symptomatic, uncomplicated, recently diagnosed diverticular disease, were randomly allocated to either crispbread vs. wheat crispbread, or ispaghula husk drink (Fybogel) vs. highly refined wheat powder drink, each given for 16 weeks at a time. The bran crispbread provided 6.99 g/d, while the Ispaghula drink provided 9.04 g/d and the placebo 2.34 g/d. Neither the physician nor the patient knew the order of treatment or the crossover date. Outcomes were based on a monthly self-administered symptom questionnaire and measurement of a seven day stool collection at the end of each treatment period. The symptoms were used to compute a "pain score," a "lower bowel symptom score" and a total score. There were no significant differences in pain, lower bowel and total symptom scores, but there was significant improvement in symptoms of constipation alone with the bran and ispaghula drink, producing expected changes in stool weight, consistency and frequency (16).

These two studies provided the best chance to demonstrate that a high-fiber diet would reduce the symptoms and complications of diverticular disease; however, the positive findings in the Brodribb, et al study (15) could not be replicated in the Ornstein, et al study (16). The Ornstein, et al (16) study has been criticized, on the basis that study patients received a fixed dose of fiber supplements which may not have been adequate to prevent the symptoms of diverticular disease (17) and that the fiber difference between the control and treatment groups was smaller than in the Brodribb, et al (18) study. The above could explain the different findings between the two studies. However, both studies had a positive effect on constipation and improved stool transit. The outcomes of both studies were based on subjective symptoms.

SUMMARY OF FINDINGS

Although most of the evidence for the association of fiber and diverticular disease is based on epidemiologic observational studies, the findings from such studies have been consistent and are based on a plausible biologic explanation. Many of the published interventional studies did not have control groups, and although their results seemed to demonstrate a significant reduction in symptoms associated with diverticular disease, the lack of a control group reduces the validity of the results. The two published randomized trials have provided inconsistent results, with Brodribb, et al (15) finding a significant reduction in pain and overall symptom score, while Ornstein, et al (16) found no significant effect on pain and lower bowel symptoms except for reducing constipation. The outcomes of most of the above studies have been based on subjective symptoms and have not had large enough sample sizes to measure objective outcomes such as the incidence of diverticulitis or complications of diverticular disease requiring endoscopic management or surgery. While these symptoms improved on a high-fiber diet used in the randomized controlled trials, the outcome variables were based on symptoms that were somewhat non-specific and subjective. The studies were not large enough to use objective outcomes such as diverticulitis or diverticular bleeding.

It is also worth commenting on the use of low-fiber diets in the setting of diverticulitis. While this practice persists today, there is no evidence to support this intervention.

CONCLUSIONS

Despite the limitations highlighted above, I believe that there is some epidemiologic evidence for a causal association between low-fiber diets and diverticular disease. However, there is less evidence that a high-fiber diet reduces symptoms and complications associ-

ated with diverticular disease; yet treating patients with diverticular disease with a high-fiber diet makes biologic, physiologic and epidemiologic sense. It is at least reasonable to recommend a high-fiber diet until large scale, well conducted, randomized controlled longitudinal studies using more objective and reliable outcomes of symptomatic diverticular disease, demonstrate either a clear benefit, or failure, that a high-fiber diet improves outcomes. ■

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