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RAPID COMMUNICATION

Increasing dietary fiber intake in terms of kiwifruit improves constipation in Chinese patients

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Abstract

AIM: To investigate if increased dietary fiber, in terms of kiwifruit, is effective in Chinese constipated patients.

METHODS: 33 constipated patients and 20 healthy volunteers were recruited for a 4-wk treatment of kiwi fruit twice daily. Response during wk 1-4 was defined as an increase in complete spontaneous bowl, motion (CSBM) $\geqslant$ 1/wk. Secondary efficacy included response during wk 1-4, individual symptoms and scores of bowel habits and constipation. Responses were compared with the baseline run-in period. Colonic transit time and anorectal manometry were performed before and after treatment.

RESULTS: Responder rate was 54.5% in the constipated group. The mean CSBM increased after treatment (2.2 ± 2.6 *vs* 4.4 ± 4.6, P = 0.013). There was also improvement in the scores for bothersomeness of constipation (P = 0.02), and satisfaction of bowel habit (P = 0.001), and decreased in days of laxative used (P = 0.003). There was also improvement in transit time (P = 0.003) and rectal sensation (P < 0.05). However, there was no change in the bowel symptoms or anorectal physiology in the healthy subjects.

CONCLUSION: Increasing dietary fiber intake is effective in relieving chronic constipation in Chinese population.

Key words: Constipation; Dietary fiber; Kiwifruit; Chinese

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INTRODUCTION

Functional constipation is a common problem in clinical practice. In the Western population, the prevalence was reported to be as high as 24% in elderly persons and more commonly among women[1]. We observed a prevalence of 14% of constipation in the Hong Kong population[2].

In mild cases of functional constipation, it has been suggested that the treatment includes general measures like increased intake of water and dietary fiber, and use of simple laxatives. A diet with enough fiber (20-35 g each day) helps form a soft, bulky stool. Sufficient dietary fiber is also needed to promote normality in bowel movement frequency over the long term[3,4]. Colonic transit has been shown to be related to stool weight and dietary fiber intake[5,6]. On the other hand, there are only a few studies that looked for dietary fiber intake by patients with chronic constipation[7-9]. In addition, in a trial with a proprietary fiber product, less than a half of the patients with self-defined constipation responded[10]. Also, anorectal physiology was not assessed in most of these studies.

Numerous anecdotal reports have suggested that kiwifruit has laxative effects, and suggested it could be an acceptable dietary supplement, especially for the elderly who often experience constipation. It has been reported that the dietary fiber in kiwifruit is about 3.4 g/100 g, thus being a good source of dietary fiber. Rush *et al*[11] has demonstrated the laxative effect of kiwifruit in the elderly subjects.

In the current study, we aimed at assessing if increasing dietary fiber intake could improve functional constipation. We chose kiwifruit to be the source of dietary fiber in the study. In addition to constipation symptoms, we also assessed if there was any improvement in anorectal physiology after fiber intake.

MATERIALS AND METHODS

Protocol

This is a single center, age and sex-matched, case control study performed from 31 December, 2006 to 31 March, 2007, consisting of a 2-wk baseline assessment and 4-wk treatment period. Both patients and controls were given two Zespril Kiwi fruit (1 in the morning after breakfast and 1 in the evening after dinner) throughout the four-week treatment period. The kiwifruit were of the green, 'Hayward' variety, and were supplied at an optimum ripeness for consumption. The kiwi fruit was dispatched in two batches, the first on d 0 and the second at the begin-

ning of wk 3 to ensure the freshness of the fruit. All the participants were seen by the investigator on d 0 and at the end of wk 4. Bisacodyl was given as rescue medicine and patients were instructed to take if no bowel motion for ≥ 4 d. The subjects were asked to fill in the diary during the 2-wk baseline period, and throughout the treatment period. Anorectal physiology tests including both colonic transit and anorectal manometry were performed for both the constipated patients and healthy controls before and after the treatment with kiwi fruit. The study was performed in accordance with the Declaration of Helsinki regarding informed patient consent and institutional review board approval.

Patients and controls

Thirty-five age ≥ 18 years constipated subjects were recruited for the study. They were recruited from the Gastroenterology outpatient clinic of Department of Medicine, Queen Mary hospital, Hong Kong, after assessment by a gastroenterologist, and satisfied the following criteria: constipation for 6 mo or more, with an average of less than three complete spontaneous bowel motion (CSBM) per week; and at least one of the following occurring for more than 25% of the time: straining, passage of lumpy or hard stools, and sensation of incomplete evacuation. Complete spontaneous bowel motion referred to the feeling that defecation led to complete passage of stool rather than partial or incomplete evacuation of stool without relief of symptoms. In addition, these patients also satisfied the Chinese constipation questionnaire[12]. Patients with a previous history of constipation predominant irritable bowel syndrome using the Rome Ⅱ criteria were excluded from the present study. Additional exclusion criteria were inability to understand Chinese, constipation due to secondary causes, history of malignancy and significant systemic disease. Pregnant or breast feeding women were also excluded. Patients who failed to complete the diary or if the constipation was not confirmed by diary were excluded.

Twenty age and sex matched volunteers were recruited by posters distributed at the university campus and community. All the volunteers were screened and then assessed by the same gastroenterologist. All the subjects will be asked to maintain normal diet pattern and activity during study period.

Assessment

Assessment of constipation symptoms was done in a diary format. Patients recorded their constipation symptoms in a diary throughout the 2-wk baseline and 4-wk treatment period. On a daily basis, they recorded the symptoms of CSBM, straining score (using a 3-point score: no straining/acceptable straining/too much straining), the 7-point Bristol stool scale form (range from 1, separate hard lumps, to 7, watery with no solid pieces)[13], and the intake of Bisacodyl as rescue medicine. Final assessment included the patients' satisfaction with bowel habits over the past week (using a 5-point ordinal scale, 0 = very satisfied, 4 = not at all satisfied), and the bothersomeness of constipation (using a 5-point ordinal scale, 0 = not at all, 4 = a very great deal).

Assessment of bowel transit time

Normal and slow transit constipation were confirmed by X-ray and colonic motility studies performed in all patients. Colonic transit time was assessed through the use of radiopaque markers, as modified from the method described by Metcalf *et al*[14] (14). In brief, 4 sets of distinctive radiopaque markers of different shapes and size (circle on d1, semi-cylinder on d 2, dot on d 3 and cylinder on d 4) were ingested by the volunteers on 4 consecutive days. X-ray of the abdomen was taken on d 5 to assess the mouth to anal transit and segmental colon transit. Transit in the right, left, and rectosigmoid colon was calculated by adding all markers seen in these regions on d 5. Slow total colonic transit was defined as > 67 h, the mean transit plus 2 standard deviations averaged from published studies.

Anorectal manometry

The manometry catheter (Zinetics Manometric Catheter, Medtronic) had a latex balloon on its tip that could be distended with air *via* a handheld syringe, and it had 8 perfusion ports spaced 0.5 cm apart beginning 2 cm below the balloon to measure pressures. The catheter was perfused with degassed water at a rate of 0.5 mL/min by a low-compliance pump (Densleeve Manometric infusion pump-16 channel E4500). The outer diameter of the catheter was 4.5 mm. Pressures were recorded and displayed using a model (Polygraph Medtronic Functional testing Software 2.05). Pressure recordings were analyzed manually.

With the patient in the left lateral position, the manometry cathether was lubricated and inserted into the rectum. It was then pulled back in 1-cm steps, and pressures were recorded at each position while the patient was instructed to relax. The peak pressure (averaged across all 8 perfusion ports) defined anal canal resting pressure. The second perfusion port was then positioned in the high-pressure zone of the anal canal, and the rectal balloon was distended with varying volumes of air (10, 20, 30, 40, 50 mL) to determine the smallest volume of distention that elicited a rectoanal inhibitory reflex (RAIR, defined as the reflex decrease in anal canal pressure that is elicited by rectal distention). Next, the rectal balloon was inflated in 20-mL steps up to 200 mL to assess the threshold for the first sensation, sensation of urge to defecate and the maximum tolerable volume. A phosphate enema was administered approximately 30 min before the anorectal manometry and balloon defecation tests.

Statistical analysis

Primary efficacy variable: The primary efficacy variable was the responder rate for CSBM during the first 4 wk of treatment. Patients with a mean increase of CSBM ≥ 1/wk compared with the last 14 d of baseline were defined as responders, provided that they had completed at least 7 d of treatment.

Secondary efficacy variables: These included the change from baseline in scores for individual constipated symptoms (stool form, straining scores, bothersomeness of constipation, and satisfaction of bowel habit). Days of laxatives used and percentage of patients needed laxatives were assessed.

Table 1 Demographic data and constipation symptoms of the constipated patients and healthy subjects

	Treatment group (n = 33)	Control group (healthy subjects) (n = 22)	P value
Sex (female)	72.70%	80%	0.74
Female to male ratio	2.67:1	04:01	
Ethnicity (Chinese)	100%	100%	
Age (yr ± SD)	49.9 ± 12	50.8 ± 14	0.82
Duration of constipation (yr ± SD)	20.3 ± 15	-	
Complete spontaneous bowel motion per week (mean ± SD)	1.9 ± 1	-	
Passage of hard stool	72.70%	-	
Incomplete evacuation	84.80%	-	
Straining	90.90%	-	

Tertiary efficacy variables: These included any improvement in anorectal physiology, which included the colonic transit time, simulated defecation pressure and also the rectal sensation.

Statistical analysis was performed using SPSS (SPSS, Chicago, IL, USA) statistical software. Demographics for patients and controls were summarized by calculating means (SD) (or median (range)) for continuous variables (for example, age and severity score) and proportions for categorical variables (for example, sex). Comparisons were performed with the Student's t test for continuous variables, and with Chi square test for categorical data. Paired t test was used to assess the bowel habit and anorectal physiology parameters before and after treatment within the same group. All statistical tests were two-sided, and p value of less than 0.05 was considered to indicate a statistically significant difference.

RESULTS

Demographic data

There were 35 patients screened, but only 33 patients were enrolled into the study. Two of them refused to participate. The demographic data, baseline constipation symptoms of both the patients and controls are summarized in Table 1. There was no difference in the demographic data as they were purposely matched. The anorectal physiology was markedly different between the constipated patients and healthy controls. These include prolonged colonic transit time and impaired rectal sensation.

Primary efficacy

The mean CSBM per week before and after treatment in patients was 2.2 ± 2.6 *vs* 4.4 ± 4.6 (P = 0.013). The responder rate, ie mean increase of CSBM ⩾ 1/wk, was 54.5% (18 patients). Whereas in the controls, the mean CSBM per week before and after treatment was 6.5 ± 1.6 *vs* 7.1 ± 2.2 (P = 0.31). There was no difference in the responder rate between those with slow and normal transit (42.9% *vs* 63.2%, P = 0.25).

Secondary efficacy

The scores for stool form, straining, bothersomeness of constipation, satisfaction of bowel habit, and use of laxatives before and after treatment are summarized in Table 2. The scores for bothersomeness of constipation and satisfaction of bowel habit were significantly lower after treatment. The number of days of laxatives used, and the percentage of patients needed laxatives as rescue therapy was lower after treatment with Kiwi fruit (Table 2). There was no significant change in bowel habits or satisfaction in the control group after treatment.

Tertiary efficacy

The parameters of anorectal physiology before and after treatment are summarized in Table 3. There was marked decrease in total colonic transit time, especially in the sigmoid-rectal segment, in the constipated patients after treatment. In addition, improvement in rectal sensation, in terms of the first sensation, urge sensation and the maximum tolerable volume and the rectoanal inhibitory reflex, was seen in the constipated patients after treatment. On the contrary, there was almost no significant change in the anorectal physiology parameters in the healthy subjects after treatment.

Safety and side effects

There were no side effects reported in both the patient and control groups. None of them, including the healthy subjects, reported diarrhea.

DISCUSSION

The current study demonstrated the efficacy of increasing dietary fiber in Chinese constipated patients, with significant improvement in complete spontaneous bowel motion, decrease laxatives used, decrease bothersomeness of constipation and improved satisfaction of bowel habit. More importantly, anorectal physiology was shown to improve significantly after treatment.

It has always been suggested that increasing dietary fiber might be helpful in patients with mild constipation. However, there have been few studies done on this area, and few studies assessed the improvement objectively using the criteria of CSBM, as well as anorectal physiology.

It is interesting to note that in this study, improvement was seen not only in the constipation symptoms, but also in terms of colonic transit time and rectal sensation in the constipated patients. It has been reported that gas production from fiber metabolism may limit acceptance, which is particularly true for bran[15] and other insoluble fibers. Despite most of the fibers in kiwifruit are insoluble fiber, none of the patients or controls reported bloating or gas, or intolerance. Voderholzer *et al*[10] reported in their study on proprietary fiber in self-defined constipation, only 20% of slow transit patients profited from fiber, whereas more than 80% of patients without identifiable cause of their complaints had a partial or complete improvement. We observed in this study that the responder rate did not differ in both groups of patients. This is probably the first study reporting an improvement in rectal sensation: the first sensation, urge and maximal tolerable volume in constipated patients after increasing fiber intake. Despite the change in anorecatal physiology parameters in constipated patients, there was no significant change observed in

Table 2 Secondary efficacy variables before and after the kiwi fruit treatment in the constipated patients and healthy subjects (mean ± SD)

	Constipated patients			Healthy subjects		
	Before treatment	After treatment	*P* value	Before treatment	After treatment	*P* value
Bristol stool scale	3.1 ± 1.9	3.3 ± 1.2	0.58	4.0 ± 0.9	4.2 ± 0.8	0.94
Straining	1.9 ± 0.5	1.8 ± 0.5	0.88	0.3 ± 0.5	0.4 ± 0.5	0.97
Bothersomeness of constipation	2.6 ± 0.9	2.0 ± 1.1	0.02	0.2 ± 0.5	0.2 ± 0.4	1.0
Satisfaction of bowel habit	2.7 ± 0.9	1.6 ± 1	0.001	0.3 ± 0.5	0.2 ± 0.5	0.97
Number of days taking laxatives (rescue therapy)/wk	2.2 ± 2.5	0.8 ± 1.5	0.003	0	0	-
Percentage of patients taking laxatives	60.60%	30.30%	0.013	0	0	-

Table 3 Anorectal physiology parameters before and after the kiwi fruit treatment in the constipated patients and healthy subjects

	Constipated patients			Healthy subjects		
	Before treatment	After treatment	*P* value	Before treatment	After treatment	*P* value
Transit time in right segment (h)	11.6 ± 12	12.6 ± 12	0.77	4.2 ± 7	4.1 ± 6	0.55
Transit time in left segment (h)	23.3 ± 16	19.6 ± 13	0.23	6.0 ± 9	6.7 ± 8	0.97
Transit time in sigmoid-rectal segment (h)	19.5 ± 16	7.6 ± 7	< 0.0001	7.2 ± 11	3.4 ± 5	0.045
Total colonic transit time (h)	54.5 ± 29	39.6 ± 22	0.003	16.8 ± 23	14.1 ± 14	0.23
Rectal pressure (mmHg)	26.3 ± 18	30.4 ± 19	0.3	23.6 ± 19	27.2 ± 18	0.54
Upper anal canal pressure (mmHg)	51.9 ± 18	48.9 ± 29	0.67	49.1 ± 20	58.4 ± 30	0.33
Lower anal canal pressure (mmHg)	63.9 ± 22	67.9 ± 25	0.44	58.4 ± 23	74.4 ± 27	0.025
Simulated Defecation-Push Maneuver (rectum) (mmHg)	65.8 ± 45	90.8 ± 55	0.019	72.2 ± 50	88.2 ± 50	0.31
Simulated Defecation-Push Maneuver (upper anal canal) (mmHg)	98.6 ± 43	108.6 ± 43	0.5	96.1 ± 46	118.1 ± 66	0.29
Simulated Defecation-Push maneuver (lower anal canal) (mmHg)	101.3 ± 47	101.1 ± 56	1.0	77.8 ± 53	90.3 ± 64	0.43
Rectoanal inhibitory reflex (R.A.I.R.) (mL)	17.2 ± 7	11.3 ± 4	0.003	12.1 ± 4	12.2 ± 4	1.0
First sensation (mL)	39.0 ± 11	33.1 ± 9	0.03	30.5 ± 9	29.4 ± 6	0.61
Constant sensation/urge (mL)	68.7 ± 20	60.3 ± 20	0.049	52.7 ± 13	50.0 ± 6	0.46
Maximum tolerable volume (mL)	99.6 ± 35	85.1 ± 21	0.031	83.2 ± 14	78.9 ± 14	0.07

normal healthy subjects. The reason for the difference in anorectal physiology response in the two groups is still unknown. However, Muller-Lissner in their meta-analysis did show that the improvement in transit time in constipated patients was greater than in healthy subjects[16].

The current study aimed at assessing the effect of increasing fiber intake in constipated subjects. However, other nutrients that are present in the kiwifruit may also contribute partly to the laxative effect. The whole fruit (minus skin) was consumed, making it difficult to isolate the mechanism. One of the novel compounds in kiwifruit that has been suggested to interact in laxation is actinidin, a proteolytic enzyme belonging to the class of thiol-proteases.

It is important to note that double blinding was impossible in this study or other studies involving dietary fiber. However, the symptoms were compared to those at the baseline, and that patients themselves were their own controls. The additional age and sex matched control group was recruited to assess if there is any side effects or change in anorectal physiology in healthy subjects. The current study thus showed that dietary fiber in terms of kiwifruit is effective in Chinese patients with functional constipation, and with improvement in anorectal physiology. Further studies on the fiber intake in both constipated patients and healthy controls are warranted. In addition, studies may be needed to dissect the individual nutrient in kiwifruit, other than fiber, that may contribute to the laxative effect.

COMMENTS

Background

Dietary fiber has been suggested to improve functional constipation. However, are only a few studies that looked for dietary fiber intake by people with chronic constipation. In addition, in a trial with proprietary fiber product, less than a half of the patients with self-defined constipation responded. Also, anorectal physiology was not assessed in most of these studies.

Research frontiers

Therefore, we investigate if increased dietary fiber, in terms of kiwifruit, is effective in Chinese constipated patients. The anorectal physiology before and after the introduction of kiwifruit was assessed.

Innovations and breakthroughs

We found that responder rate to kiwi fruit was 54.5% in the constipated group. They have improvement in complete spontaneous bowel motion per week, symptom scores for constipation, as well as in colonic transit time.

Applications

Increase dietary fiber may improve functional constipation.

Peer review

This article is novel and provides an insight in the pathophysiology of constipation.

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