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Assessment of the effect of increased dietary fibre intake on bowel function in patients with spinal cord injury

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It is common for constipation to occur following severe spinal cord injury (SCI). Although a bowel management program including a high fibre diet is an integral part of rehabilitation,[1] the effect of a high fibre diet on large bowel function in SCI has not been examined. The aims of this study were to assess the nutrient intake of SCI patients, to determine baseline transit time, stool weight and evacuation time and to assess the effect of addition of bran on large bowel function. Eleven subjects, aged 32 ± 10.5 years participated in the study. The level of injury ranged from C_4 to T_{12}; only one patient had an incomplete injury. Baseline mean energy intake was 7823 ± 1443 kJ/d, protein intake 93 ± 21 g/d, carbohydrate intake 209 ± 39 g/d and mean dietary fibre intake 25 ± 8 g/d. Mean baseline stool weight was 128 ± 55 g/d and bowel evacuation time was 13 ± 7.4 min/d. Three subjects who consumed <18 g dietary fibre/d had low stool weights of 60-70 g/d and two had very delayed transit times that were too slow to enable quantitation. Mean mouth to anus transit time was 51.3 ± 31.2 h, mean colonic transit time 28.2 ± 3.5 h, right colonic transit time 5.9 ± 4.5 h, left colonic transit time 14.5 ± 5.2 h and rectosigmoid colonic transit time 7.9 ± 5.6 h. Following the addition of bran, dietary fibre intake significantly increased from 25 g/d to 31 g/d ($P < 0.001$). However, the mean colonic transit time increased from 28.2 h to 42.2 h ($P < 0.05$) and rectosigmoid colon transit time increased from 7.9 to 23.3 h ($P < 0.02$). Stool weight, mouth to anus, left and right colon transit time and evacuation time did not change significantly. Results of this study suggest that increasing dietary fibre in SCI patients does not have the same effect on bowel function as has been previously demonstrated in individuals with 'normally functioning' bowels. Indeed the effect may be the opposite to that desired. This preliminary study highlights the need for further research to examine the optimal level of dietary fibre intake in SCI patients.

Keywords: dietary fibre; colonic transit time; stool weight; spinal cord injury

Introduction

Constipation following severe SCI is the consequence of a number of factors including loss of bowel sensation, loss of voluntary control of defaecation and alteration of large bowel motor activity. Alteration in large bowel motor activity is thought to result in abnormal transit times and gastrointestinal morbidity. Abnormal large bowel transit has been demonstrated and found to be mainly at the level of the left colon and rectum.[2,3] Mean colonic transit time has been reported to be doubled in SCI patients[3] and differences between patients with high and low motor neuron lesions have been found.[4] In patients with high lesions, resting colonic activity was reduced compared with normal subjects, whereas those with low cord lesions had increased motility.[4]

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Few studies have examined the occurrence and functional significance of chronic gastrointestinal problems in individuals with SCI. Glick *et al*[5] have shown a decrease in colonic compliance and an absence of a post prandial increase in colonic motor and myoelectrical activity in patients with thoracic paraplegia. Faecal impaction was found to be the most common chronic complication in an audit conducted by Gore *et al*[6] and comprised 45% of all gastrointestinal complications. Similarly, in another audit, chronic gastrointestinal symptoms occurred in 27% and difficulty evacuating occurred in 20% of patients. Those with difficulty evacuating spent longer, approximately 74 min per day, on routine bowel care compared with those who were asymptomatic, 30.5 min per day.[7]

Nutrient intake and requirements of SCI individuals are yet to be clarified. Some research has been conducted in the area of dietary intake in acute and chronic phases of rehabilitation, however, limited information is available concerning longitudinal dietary habits and in particular dietary fibre intakes and requirements or the effect of dietary fibre intake on constipation and gut transit times. Mendaro *et al*, recorded that subjects studied continued their diet containing 2270 kcal and 16.4 g 'dietary fibres'.[2] There has been no other attempt to quantify fibre intakes in SCI patients apart from a study by Levine *et al* where it was demonstrated that men consumed 12.2 g fibre daily and women 14.3 g.[8]

It is well documented that fibre in the form of wheat bran increases stool weight and decreases colonic transit time in healthy individuals, or individuals with diverticulae and constipation. In spinal units SCI individuals are usually recommended to increase their fibre intake, but it is not known what effect this will have on bowel function in this special group of patients. The aims of this study were to assess baseline dietary intake, transit time, stool weight and bowel evacuation time and to determine the effect of extra dietary fibre on these parameters.

Methods

Subjects and experimental design

Eleven subjects participated in the study. All were in their first rehabilitation program 1–4 months after SCI. Their bowel management routine included one subject who used fruit laxative (Nu-Lax) and senokot tablets, three used bisacodyl (Durolax) suppositories and sennoside B (Senokot) tablets, one used sennoside B tablets and bisacodyl enema, two used sennoside B tablets, bisacodyl enema and dioctyl sodium sulphosuccinate (Coloxyl) one used sennoside B, fruit laxative, dioctyl sodium sulphosuccinate and bisacodyl enema, one used sennoside B granules and bisacodyl enema, another used sennoside B granules, bisacodyl suppository, fruit laxative and dioctyl sodium sulphosuccinate. One subject used no medication. There were 10 male and one female patients, with a mean age of 32 years (range 19–35) (Table 1). Level of injury ranged from C_4 to T_{12}. Only one subject had an incomplete lesion. All patients had fully recovered from spinal shock.

Table 1 Subject characteristics

Patient	*Gender*	*Age*	*Injury level*	*Neurology*	*Bowel sensation*
1. LC	M	29	T10	Incomplete	Yes
2. JT	M	19	C5	Complete	No
3. RV	F	43	T5	Complete	No
4. WB	M	29	T4	Complete	No
5. SW	M	21	C5	Complete	No
6. GM	M	53	C6	Complete	No
7. JW	M	25	C7	Complete	No
8. DC	M	26	T12	Complete	No
9. GC	M	33	C4	Complete	No
10. CS	M	27	C4	Complete	No
11. JD	M	43	C8	Complete	No

The study was performed in accordance with the declaration of Helsinki and with approval of the Austin Hospital Research Ethics Committee and the Deakin University Ethics Committee and with informed consent of the subjects.

In phase 1 (week 1) subjects ate a normal hospital diet and maintained their bowel routine. In phase 2 (weeks 2–4) fibre intake was increased with the addition of 40 g Kelloggs All Bran. During weeks 1 and 4 stool weight, total and segmental transit time, bowel evacuation time and dietary intake were assessed.

Collection and weighing of stools

Stools were collected in plastic bags that were placed over the pan at the base of the commode chair. Each stool was collected in a separate plastic bag and placed in a separate container. Subject, date and time of collection were recorded on the outside of the container. Stools were weighed on Mettler P1000 scales with correction for plastic bag and container.

Total and segmental colonic transit time

In the last week of each phase (weeks 1 and 4), one gelatin capsule containing a total of 20 radiopaque markers prepared from various French gauge catheter tubes was ingested at the same time on day 1 and day 2 of these weeks. On the third day a 'stitzmark capsule' was ingested. The capsules ingested each day contained markers of a different shape. On days four and seven of the last week of each phase abdominal X-rays were obtained using a high-kilovoltage fast film technique in order to reduce radiation exposure (estimated surface exposure = 0.08 mrad per film). All capsules and X-rays were taken at the same time of day for each patient.

Stools were collected and X-rayed. The different marker types were distinguishable on both abdominal films and radiographs of the stools. Markers were located anatomically on abdominal films using the spinal processes and imaging lines from the fifth lumbar vertebra to the left iliac crest and pelvic outlet as landmarks. In the absence of clear outlines of the bowel, markers located to the right of the vertebral spinous processes above a line from the fifth lumbar vertebrae to the pelvic outlet were assigned to the right colon. Markers to the left of the vertebral spinous process and above an imaginary line from the fifth lumbar vertebrae to the anterior superior iliac crest were assigned to the left colon. Markers inferior to a line from the pelvic brim on the right and the superior iliac crest on the left were judged to be in the rectosigmoid and rectum. However, if the bowel outlines clearly showed a pelvic caecum, a transverse colon, or a large sigmoid loop above the fifth lumbar vertebrae, markers were judged to be in the anatomic segment based on gaseous outlines. For each film, markers ingested on days 1, 2 and 3 were assigned to one of the colonic segments.[9] Subjects remained on their usual aperients for the duration of phases 1 and 2.

Bowel chart
Nursing staff completed a bowel chart each time the patients' bowels were opened. The details on the chart included aperients administered, the type and quantity and the time at which the bowels were opened. The evacuation time was defined as the time taken from getting on to the commode or toilet until defaecation. This was also recorded on the chart. Complications such as gas, abdominal pain and distension were noted, as were other methods used to facilitate bowel evacuation.

Assessment of dietary intake
For five days during the final week of each phase, patients' menu choices were documented. Patients were asked not to change their usual dietary patterns. Twenty-four hour recalls were performed to cross check intake with what was ordered from the menu and to obtain information about any extra food items and drinks consumed. The cross check was used to minimise errors. Patients were asked each day to recall what they had eaten and drunk in the previous 24 h and to estimate how much of each serve they had consumed, eg. half, all. If there was no recall of items that had been ordered from the menu patients were questioned as to whether they had consumed the items. Patients who went on leave during the measurement phases were asked to estimate and record all foods and drink consumed using standard kitchen measures such as cupfuls, spoonfuls, etc. Families and friends were of assistance if the patient was unable to write or prepare his own food.

The chefs at the Austin Hospital follow standardised recipes and food is served in 'standard' serving sizes. Dietary compliance was assessed from foods recorded, nursing staff reports and spot checks at breakfast time. Computerised dietary analysis was performed using Diet 3 (Xyris Software), which includes the standardised recipes used on the hospital menu.

Statistical analysis

Comparisons of data between phases 1 and 2 were made using the paired T-test.

Results

Nutrient intake
Results obtained from nutrient analysis of phase 1 and phase 2 dietary records are shown in Table 2.

Comparison of nutrient intakes between phase 1 and phase 2 using the paired *t*-test reveals that dietary fibre is the only component that changed significantly with a mean of 25 ± 7.6 g/d in phase 1 and 31 ± 9.7 g/d in phase 2 ($P < 0.001$) (Figure 1). Insoluble and soluble fibre intakes were determined from literature values quoting dietary fibre components as measured by the Englyst and modified Southgate methods,[10–12] and

Table 2 Summary of nutrient intake details

Nutrient	*Mean Phase 1*	*Mean Phase 2*	*Statistical comparison*
Energy (kJ)	7823 (1443)	7771 (1489)	n.s.
Carbohydrate (g)	209 (39)	207 (44)	n.s.
Fat (g)	69 (19)	69 (14)	n.s.
Protein (g)	93 (21)	90 (18)	n.s.
Alcohol (g)	5.8 (13)	7 (16)	n.s.
Fibre (g)	25 (8)	31 (10)	$P < 0.0009$

( ) refers to the standard deviation

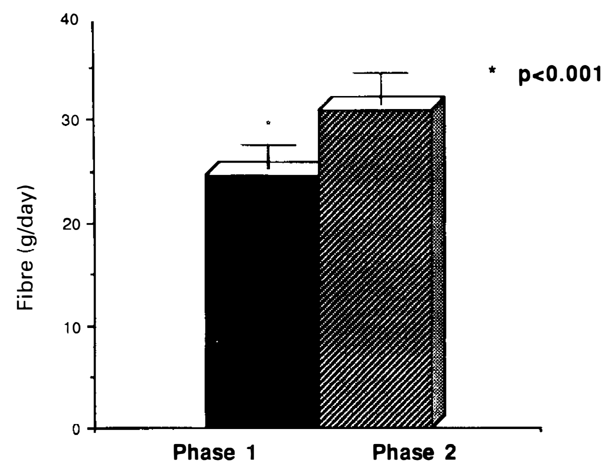

Figure 1 Comparison of fibre g/day between Phase 1 and Phase 2

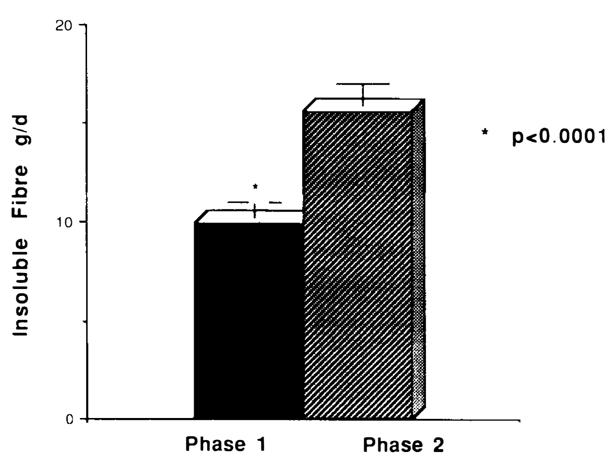

Figure 2 Comparison of insoluble fibre intake between Phase 1 and Phase 2

Figure 2 demonstrates that it was insoluble fibre that increased significantly ($P<0.0001$). Looking at different groups of foods consumed it was estimated that resistant starch intake remained relatively constant.

Bowel function
Table 3 shows the mean and standard deviation of stool weights and gut transit times, including a segmental breakdown into total colonic, left, right and rectosigmoid. It shows that the only significant difference was that additional bran (phase 2) increased mean colonic transit time due to a greatly prolonged rectosigmoid transit.

Table 3 Summary of bowel function measurements

Measurement	*Mean Phase 1*	*Mean Phase 2*	*Statistical comparison*
Stool weight (g/d)	128.0 (55)	137.0 (51)	n.s.
Time taken (mins/d)	13.0 (7.4)	14.0 (9.3)	n.s.
Mouth to anus transit time (h)	51.3 (31.2)	67.5 (12.8)	n.s.
Mean colonic transit time (h)	28.2 (3.5)	42.2 (9.2)	$P<0.05$
Right colon transit time (h)	5.9 (4.5)	16.0 (10.1)	n.s.
Left colon transit time (h)	14.5 (5.2)	18.7 (4.6)	n.s.
Rectosigmoid colon transit time (h)	7.9 (5.6)	23.3 (11.1)	$P<0.02$

Table 4 shows results of bowel function measurements for individual subjects grouped according to their baseline fibre intake. Subjects 1 and 3, with dietary fibre intakes of <18 g/d had transit times which were too slow to calculate in phase 1. All three patients with fibre intakes <18 g/day had low baseline stool weights between 60–70 g/d. X-rays of subject 2 were misplaced, thus the transit time is not known.

All subjects with baseline fibre intakes between 19–30 g/d and 30+ g/d were able to have transit time calculations made. Stool weights for these two groups ranged from 89–223 g/d. One subject who consumed an average of 34 g fibre/d had no markers present on the first X-ray and hence a mean colonic transit time of <35 h was assigned to him.

Using the paired *t*-test comparisons of baseline bowel function measurements and those following intervention are depicted in Table 3. Stool weight or evacuation time did not change significantly. Mouth to anus transit time increased by 16.2 h, but this change was not statistically significant. However, mean colonic transit time, as illustrated in Figure 3,

Table 4 Comparison of bowel function measurements, based on Phase 1 baseline fibre intake

Subject	*Fibre 1 (g/d)*	*Stool weight (g/d)*	*Time taken (mins/d)*	*Mouth to anus transit time (h)*	*Mean colon transit time (h)*	*Right colon transit time (h)*	*Left colon transit time (h)*	*Rectosig. colon transit time*
< 18 g fibre/day								
1. LC	1. 14	60.4	6	95.8	#	#	#	#
	2. 22	54	2	78.2	52.8	0	15.8	36.9
2. JT	1. 18	60.3	9	*	*	*	*	*
	2. 25	75	10	*	*	*	*	*
3. RV	1. 16	69.5	10	#	#	#	#	#
	2. 22	106	9	#	#	#	#	#
19–30 g fibre/day								
4. WB	1. 26	137	12	66	27.1	12.3	8.6	3.7
	2. 24	131	13	#	#	#	#	#
5. SW	1. 23	89	9	40.3	27.1	1.23	22.1	1.2
	2. 30	101	6	64.5	32.7	0	25.7	6.1
6. GM	1. 28	153	30	43.4	26.5	2.5	12.3	11.4
	2. 39	172	23	46.9	37.5	0	12.5	25.0
7. JW	1. 22	186	20	58.7	24.0	2.4	8.4	13.2
	2. 28	174	25	72.3	48.0	4.8	20.4	22.8
8. DC	1. 22	140	10	66.9	27.6	8.4	20.4	0
	2. 21	212	9	61.0	31.2	10.8	14.5	7.9
30+ fibre/day								
9. GC	1. 37	180	12	75.4	30.3	0	18.4	11.9
	2. 45	118	8	86.0	53.2	27.2	0	25.9
10. CS	1. 34	223		35.2	<35	0	0	0
	2. 47	164		63.2	40	21.3	17.5	3.7
11. JD	1. 33	114		82.3	34.8	8.7	13.6	12.4
	2. 39	196	30	#	#	#	#	#

# indicates that transit time calculations were unable to be determined due to very delayed transit. * indicates that transit time calculations were unable to be determined due to misplaced films

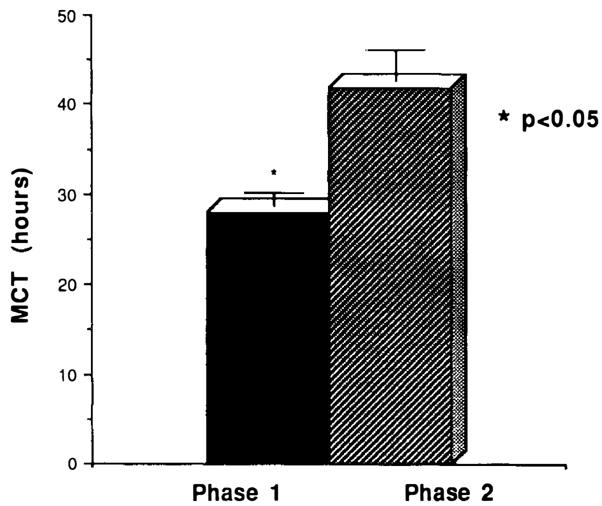

Figure 3 Comparison of mean colonic transit time (MCT) between Phase 1 and Phase 2

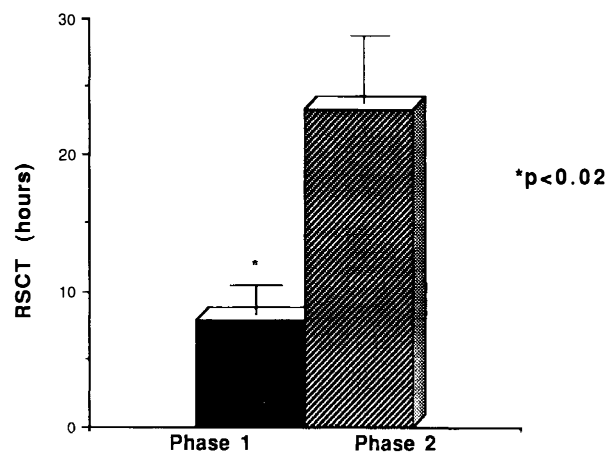

Figure 4 Comparison of rectosigmoid colon transit time (RSCT) between Phase 1 and Phase 2

increased from 28.2±3.5 h to 42.2±9.2 h ($P<0.05$), which was almost equivalent to the change in mouth to anus transit time. Right colonic transit time increased from 5.9±4.5 h to 16±10.1 h, but this was not statistically significant, nor was the change in the left colon transit time. Following addition of extra dietary fibre, rectosigmoid colonic transit time increased from 7.9±5.6 to 23.3±11.1 h ($P<0.02$), as depicted in Figure 4.

Table 4 illustrates changes in individual subject bowel function.

Discussion

The present study was undertaken to assess the nutrient intake of spinal cord injured patients and to determine baseline transit time, stool weights and bowel evacuation time. The aim was to determine whether dietary intervention by addition of dietary fibre in the form of 40 g 'All bran'/day, containing 9.3 g fibre would result in improved large bowel function.

Nutrient intake

The average dietary fibre intake of SCI subjects was 25 g/d, which is higher than the only previous studies in SCI subjects where fibre has been quantitated. Mendaro *et al* reported that subjects consumed 16.4 g 'dietetic fibres'[2] and Levine *et al* reported that women consumed 14.3 g fibre/d and men 12.2 g/d.[8] The current study group also had a higher intake of dietary fibre than the Australian average of 17 g/d. This relatively high baseline dietary fibre intake is probably because a high fibre diet is recommended in the patient education manual and the nursing staff, when educating patients regarding bowel management, discuss and constantly reinforce this.

Nutrient intake was assessed by a combination of recording subjects' menu choices and a 24 h recall to cross check intake. Ideally, for optimal accuracy a weighed food intake record would have been utilised, but at the time of the study this was not possible. Compared with the study of Levine *et al* the current subjects were consuming slightly more energy (1863 kcal/d compared with 1682 kcal/d) and more protein (93 g/d compared with 69 g/d). Hence, the current subjects not only consumed more energy and protein but also more dietary fibre. This may be accounted for by the fact that patients in Levine's group were living at home and had been injured for greater than 4 years, consequently activity could have been less than the current group who were actively participating in rehabilitation. Food frequency questionnaires, which were utilised in Levine's study may tend to overestimate consumption, thus the difference may in fact be greater.[8] Other studies of nutrient intake in SCI have focused on the acute phase or compared the intakes of paraplegic subjects with tetraplegic subjects, but numbers of subjects in the current study were too small for this comparison.

The addition of 40 g 'All Bran'/day (9.3 g dietary fibre) resulted in a mean increase of 6 g dietary fibre in the form of insoluble fibre. The increase in fibre was less than anticipated, probably because individuals found it difficult to consume the 'All Bran' as well as their usual high fibre diet. In two patients dietary fibre intake decreased by 1 and 2 g/d. They both consumed amounts of fibre above the average Australian intake. They also recorded a decrease in energy intake. Soluble dietary fibre intake remained constant throughout both phases. Resistant starch was not calculated separately because the amount of resistant starch in a food is highly dependent on the way in which the food is handled and there are currently no reliable means of determining the quantities present in foods as they are consumed.[12] Looking at the food groups likely to contain resistant starch it was estimated that most subjects consumed similar amounts during both phases.

Baseline bowel function
Many studies[14-18] in non-SCI individuals have shown an increase in stool weight with an increase in dietary fibre intake. In the current study mean baseline stool weight was similar to non-SCI individuals and the individual with the lowest stool weight had the lowest fibre intake, whereas the individual with the largest stool weight had the second highest fibre intake.

The average bowel evacuation time was 13 min/day without the addition of extra fibre. Individuals who took less than 20 min to evacuate their bowels were on second daily bowel routines, whereas those who took 20 and 30 min opened their bowels daily. There was a large range in mouth to anus transit times and mean colonic transit times, with differences in colonic transit time occurring between the various colonic segments. The segment that had the slowest transit time was the left colon. In non-SCI individuals mean colonic transit time is 39 h and transit time is not significantly different between colonic segments. The baseline mean colonic transit of spinal cord injured patients (28.2 h) whilst on usual aperients is shorter than in non-SCI individuals.[9] Subjects were not divided into high and low cord lesions when calculating transit time data because there were only two subjects with low cord lesions. Excluding subjects with low cord lesions, mean colonic transit time was also not significantly different (28.3 h).

When grouped according to baseline fibre intake certain trends in bowel function are evident. Eighteen grams fibre/day and less was chosen as the low fibre group because this is close to the current Australian average. Two of the subjects in the low fibre group had transit times that were delayed beyond day 7 and stool weights in this group were low (60–70 g/day). It is apparent that the transit time method chosen for this study is inappropriate for measuring extremely delayed transit times. Nineteen to thirty grams fibre/d was chosen as the medium fibre group and mean colonic transit time in this group ranged from 24 to 27.6 h. The 30+ g fibre/d group (high fibre) had transit times that were slower, 30.3 h and 34.8 h though one subject in this group had the shortest transit time. There did not appear to be a relationship between the dosage of aperients, specifically sennoside B, and transit time. This relationship between dietary fibre and bowel function illustrates the importance of taking diet into consideration. In studies that have found differences between patients with high and low cord lesions subjects diets have been uncontrolled or not considered.[4,19] The differences may therefore have been due in part to variations in dietary fibre intake which may also have a considerable effect on colonic compliance and myelectrical activity.[5]

In the latter group the delay was at the level of the left colon and to a lesser extent the rectosigmoid colon. The location of the delay was consistent with data of Nino-Murcia *et al* who found a right colon transit time of 17.23 h, left colon transit time of 31.67 h and rectosigmoid transit time of 31.8 h with a total transit time of 80.7 h.[3] However, results of all colonic segments are somewhat longer than those of the current study. This is probably because all subjects in the prior study had bowel care regimens involving digital stimulation of the rectum and no laxatives or enemas, whereas the current subjects remained on their usual bowel routines which involved the use of aperients and suppositories or enemas. In an initial pilot study patients were taken off their aperients whilst transit time was being measured, but difficulties arose with constipation and subjects required manual evacuation of their bowel. Therefore it was decided that medications would be left constant and fibre intake would be the only change made. Mendaro *et al* also found abnormal transit through the left colon and rectum in 11 paraplegic subjects who were not allowed drugs or enemas from 48 h prior to ingestion of markers. Results in Mendaro's study are expressed as transit index, so cannot be compared to the results obtained in this study.[2]

Results of mean colonic transit time in the high fibre group were similar to those of normal adults, 39 h.[9] However, in normal adults no difference in transit times of the various colonic segments has been reported. The less than normal mean colonic transit time of our study was probably due to the spinal cord injury.

Intervention bowel function
The increase in dietary fibre intake resulted in an increase in mean colonic transit time, with a fourfold delay occurring at the rectosigmoid colon. Stool weight, time take to open bowels and mouth to anus transit time did not alter significantly. However, in the two patients (1 and 3) with low fibre intakes initially, mouth to anus transit time was reduced when dietary fibre was increased in phase 2.

With the extra dietary fibre mean stool weight increased, but this was not statistically significant. The lack of change in stool weight may be because 'All Bran' is particularly fermentable, soluble fibre 5.24 g/100 g dry weight and of fine particle size.[11] The more soluble the fibre and the smaller the particle size of the bran, the smaller the change in stool weight.[14,15] As a consequence of the slower transit time with the extra fibre there was also more time for bacterial degradation and fermentation to occur and hence reduced water-holding capacity of the fibre which may also explain the lack of significant increase in stool weight. The mean increase in dietary fibre may also be insufficient to cause a significant change in stool weight. A decrease in bacterial mass has also been demonstrated with an increase in mean colonic transit time when motility is slowed with Lomotil.[16] Muller-

Lissner *et al* in a meta-analysis of 27 studies in which wheat bran was prescribed and large bowel function measured reported that there is no justification for claiming bran treatment in constipation can return stool output to normal.[17]

The time taken to open the bowels was also not significantly different and no trends were apparent. It is probable that the non-dietary component of the bowel management program, that is the aperients, enemas and other methods such as digital stimulation and abdominal tapping that stimulate reflex activity are the crucial factors relating to time to open bowels. It is not known if dietary fibre interacts with these drugs and enhances or decreases their action. Mouth to anus transit time did not alter significantly during phase 2, but there was a trend towards an increase. All subjects in the more than 30 g fibre subgroup experienced an increase in mouth to anus transit time. Whether dietary fibre influences colonic activity by changes in bowel compliance or myoelectrical activity was not studied but would be of interest.[5]

The mean colonic transit time increased significantly with the increase in dietary fibre, the main increase occurred in the rectosigmoid colon. Left colon transit time did not change significantly with the increase in dietary fibre, but there was a tendency for the transit time to increase in this segment of the colon. Thus it seems that additional fibre did not further delay left colonic transit which was delayed compared with normal in phase 1, whereas the mean right colon transit time increased. This change was not statistically significant, probably because there were six subjects who did not have markers in the right colon in one of the phases and two whose transit time was so delayed it could not be calculated using this transit time method, thus there was only paired data for two subjects.

The increase in the mean colonic and the rectosigmoid transit time with the addition of dietary fibre in SCI appears to be unique to this group of subjects.[18,20–22] One possible explanation is that finely ground wheat bran has less effect on stool moisture than coarse bran and transit is actually slowed if particles are ground sufficiently finely.[14,15,23] It is possible that in our study the finely ground wheat bran ('All Bran') had this effect. Alternatively fibre may bind some of the medication in the colon and consequently negate its effect or the method for assessing colonic transit time used in this study was inappropriate for this group of patients. Further research is required to examine the effect of dietary fibre on colonic function in SCI patients with different levels of injury.

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