Original Article

Novel Effects of Traditional Wooden Toothbrush on Bowel Motility Symptoms in Spinal Cord Injury Patients; Findings from a Pilot Quasi-experimental Study

Abstract

Background: The aim of this study was to investigate the therapeutic effect of traditional wooden toothbrush usage on most severe constipation, which usually occurs in spinal cord injury (SCI) patients. **Methods:** In a quasi-experimental study, 61 SCI patients were selected who had injuries in different spinal levels (cervical, thoracic, and lumbar), and severe constipation from one defection in a few days to 3 weeks. They were recommended to use traditional wooden toothbrush for 5 min twice a day, after breakfast and dinner, over a 6 weeks period. Two proper standard scales, called neurogenic bowel dysfunction (NBD), and "Constipation Assessment Scale (CAS)," were used for evaluating the changes in patients' gastrointestinal (GI) habits during the period of using the wooden toothbrush. Through these scales (NBD and CAS), the therapeutic effects of traditional wooden toothbrush usage on the severity of constipation before and after intervention were measured. **Results:** The mean of NBD and CAS scores were reduced significantly, from 8.95 ± 0.78 and 3.34 ± 0.28; respectively, to 3.03 ± 0.57 and 1.74 ± 0.25, after 6 weeks using traditional wooden toothbrush ($P < 0.0001$). There was a significant difference in terms of NBD scores in patients with different levels of injury ($P < 0.01$), particularly in patients with thoracic injury, before (10.52 ± 0.88) and after (3.13 ± 0.78) treatment, respectively ($P < 0.0001$). Eventually, all symptoms of bowel problems improved significantly after the intervention ($P < 0.05$). **Conclusions:** The use of traditional wooden toothbrush lead to the improvement of bowel and defecation problems in SCI patients. Yet more studies, particularly randomized control clinical trials are needed to investigate the effect of using wooden toothbrush on other GI reflexes. In addition, if some clinical trials are devised to study the effects of wooden toothbrush on both conscious and unconscious patients in ICU, best results are expected to be found on keeping their mouth and teeth hygiene, as well as, getting rid of their constipations.

Keywords: *Constipation, spinal cord injury, traditional wooden toothbrush*

Ebrahim Esfandiari, Awat Feizi[1], Zahra Heidari[1], Seyed Reza Tabibian[2], Pooria Shaabani[2], Bijan Iraj[3], Payman Adibi[4], Amrollah Ebrahimi Varzaneh[5]

Department of Anatomical Sciences and Molecular Biology, School of Medicine, Isfahan University of Medical Sciences, Isfahan, Iran, [1]Department of Biostatistics and Epidemiology, School of Health, Isfahan University of Medical Sciences, Isfahan, Iran, [2]Medical Students Research Centre, School of Medicine, Isfahan University of Medical Sciences, Isfahan, Iran, [3]Isfahan Endocrine and Metabolism Research Centre, Isfahan University of Medical Sciences, Isfahan, Iran, [4]Department of Internal Medicine, Integrative Functional Gastroenterology Research Centre, Isfahan University of Medical Sciences, Isfahan, Iran, [5]Fellow of Gastroenterology, Department of Internal Medicine, Isfahan University of Medical sciences, Isfahan, Iran

Address for correspondence:
Amrollah Ebrahimi Varzaneh, Fellow of Gastroenterology, Department of Internal Medicine, Isfahan University of Medical sciences, Isfahan, Iran.
E-mail: am_ebrahimi@mui.ac.ir

Introduction

Constipation is one of the most common gastrointestinal (GI) tract problems that is clinically defined as: defecation <3 times a week.[1] The prevalence of constipation was estimated between 4% and 28% in the United States of America (USA)[2,3] and 1.4%–37% in Iran.[4] The prevalence of constipation tends to increase with age. The studies reported that approximately 26% of men and 34% of women over 65 years of age suffer from constipation.[5] Each year 2.5 million patients with constipation refer to physicians in the USA, and constipation treatment costs the American Society approximately 29 billion dollars/year.[6,7] Some factors considered as the cause of constipation include neurologic diseases, hypothyroidism, metabolic disorders, abnormal intrinsic motility, and lack of extrinsic innervations (in paraplegia).[8,9] Constipation has been reported as the most common GI complication of spinal cord injury (SCI) patients with the prevalence of approximately, 42%–81%.[10]

Most patients can be treated with dietary fiber and/or laxatives (water-binding laxatives, stimulating laxatives and prokinetic agents).[9] However, one-third of patients do not show any response to such treatments.[11] Due to the economic and social burden of this medical problem, finding a simple, inexpensive, and effective treatment that could improve the quality of life for these patients seems to be an urgent necessity. Therefore, we tried to find

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a technique of reflex therapy according to neuroanatomical fact in GI innervation.

Neuroanatomical basis of this study

The parasympathetic innervations of GI tract, which is responsible for gut peristaltic activity, are divided into two parts: the cranial part and the caudal part. The former is supplied by vagus nerve which innervates derivatives of the foregut and the midgut, extending from pharynx to the splenic flexure of transverse colon. The latter caudal part is supplied by sacral parasympathetic fibers (S2-S3-S4), which innervates derivatives of hindgut that extend from descending and sigmoid colons, and also, the rectal canal. As mentioned above, these nerve fibers promote peristalsis and lead to the enhancement of GI movements.[12,13]

According to neuroanatomical facts, there is a nervous band, called "Medial Longitudinal Fasciculus (MLF)," predominantly in the brain stem and cervical spinal cord which connects 8th and 6th cranial nerve nuclei.[14] Therefore, a hypothesis was formed in the mind whether or not MLF connects some other cranial nerve nuclei together. If so, it could be considered that 5th sensory cranial nucleus and 10th cranial nerve nuclei (dorsal motor nucleus of vagus), might be connected together by MLF, as well. This connection might be the nervous band through which what we call "mouth – colic reflex" works.

Therefore, we assumed that using dental floss or traditional wooden brush might lead to stimulating trigeminal nerve endings under the gum epithelium, which in turn, leads to stimulating the vagus nerve through the above-mentioned reflex. This is a neuroanatomical fact that vagus nerve has its special pass way through mediastinum and abdominal cavities and spinal lesions do not interfere its structure and function.

Methods

Study design and participants

This quasi-experimental study was conducted during January and February 2013 in a rehabilitation center in the city of "Shahr-e Kord," in central Iran, our target population was 91 SCI patients under treatment by this center from which 61 patients agreed to participate in this study and each participant filled out the consent form. These patients had been injured at least 2 years ago and had injuries in different spinal levels. Spinal injuries were distributed at thoracic, cervical, and lumbar levels as; 53.3%, 6%, and 8%, respectively [Table 1].

Procedures and variables assessment

The patients were advised to use wooden toothbrush twice a day after breakfast and after dinner for at least 5 min. They followed the instruction for 6 weeks. Physicians and nurses taught the patients how to use the wooden toothbrush properly, according to the instructions mentioned in 2.4. Nurses contacted the patients by phone three times a week and visited them every 2 weeks.

Table 1: Demographic and clinical characteristics

Variable	*n* (%)
Age	
<30	11 (18.0)
30-40	17 (27.9)
40-50	17 (27.9)
>50	16 (26.2)
Sex	
Male	50 (82)
Female	11 (18)
Level of injury	
Cervical	6 (10)
Thoracic	32 (53.3)
Lumbar	14 (23.3)
Thoracolumbar	8 (13.3)

Assessment of defecation symptoms

Two proper standard scales, "the neurogenic bowel dysfunction (NBD)", and "the Constipation Assessment Scale" (CAS), were distributed as two questionnaires to patients and they were advised to complete them by answering how using the wooden toothbrush has changed their GI habits. NBD is a questionnaire based on symptom score for clinical assessment of colorectal and anal dysfunction in SCI patients NBD scales consists of four items which evaluate the defecation features, while the CAS includes eight items, each deals with signs and symptoms of the disease, such as bloating, pain, and small stool, which altogether help measuring the bowel problem.

As pointed out above, in NBD scale, items are about the frequency of defecation, duration of defection, digital stimulation for evacuation, and the frequency of incontinence, respectively. Scores 0–9 indicate very minor or minor constipation and scores higher than that indicate moderate or severe constipation. While, in CAS scale, each item includes a three-point rating scale as the following: no problem, some problem, and severe problem, and their Scores are 0, 1, or 2, respectively. These scores are added to make a range between 0 for no constipation and 16 for the most severe constipation; the validity and reliability of both scales have been evaluated.[14,15]

Traditional wooden toothbrush

The wooden toothbrush is a special toothbrush which is made from thin branches of a tree plant, called *Salvadora persica*, mostly harvested at Yemen coastal areas and is commonly known as "the toothbrush of Mecca," or "the tooth brush of." Muslims' beloved prophet Mohammad, peace be upon him, firmly advised them to use the Arak wooden toothbrush in about 620 AD, in Madinah, the second important city of Hejaz Arabic country. This plant contains a chemical substance called "tannin" which has antibacterial, antimouth odor, anti-tooth germ, and anti-inflammatory agent. Some personal experiments show that painful mouth aphthous ulcers which usually take 2 weeks painful period to get spontaneously cured, if brushed by the wooden toothbrush for a few times, though very painful, will be surprisingly cured within one or 2 days. Using wooden toothbrush three times a day can cure edematous painful bleeding gums, within 3 days. Therefore, wooden toothbrush has been proved to be, both physically and chemically, much effective on dental and mouth hygiene. It should be used like a normal brush, vertically and transversely and in mouth vestibule. After using the wooden toothbrush, the brush should be washed with tap water and kept dry for the next use. However, the mouth should not be washed and rinsed since small particles of wood remained on the teeth and in the mouth will ensure its full effect on the teeth and gums.

Statistical analysis

SPSS statistical software program version 21 (SPSS Inc., Chicago, IL, USA) was used for statistical analysis. The results were presented as descriptive statistics (mean ± standard error [SE], median [interquartile range], and number [percentage]) for quantitative and qualitative variables, respectively. Paired samples *t*-test, McNemar test, analysis of variance, and Pearson's correlation coefficient were used for analyzing data. $P < 0.05$ was considered statistically significant.

Results

Ninety-one patients had the inclusion criteria in this clinical trial, but 61 patients participated in our study. The mean ± standard deviation age of subjects was 41 ± 12.35 years; with a range of 23–74 years. Eighty-two percent of participants were male, and 18% were female. Levels of injury in different parts of the body and the number of participants in different sex and age groups are shown in Table 1.

In the CAS scale, the mean of abdominal distension was 0.45 ± 0.56 and 0.18 ± 0.37 and for less frequent bowel movements was 0.40 ± 0.58 and 1.11 ± 0.51 before and after intervention, respectively. The CAS mean scores before and after intervention were 3.34 ± 2.19 and 1.73 ± 1.96, respectively ($P < 0.001$). As the Table 2 shows, all bowel problems improved significantly after intervention.

For total sample, the mean of NBD scores before and after intervention were 8.95 ± 0.78 and 3.03 ± 0.57, respectively ($P < 0.0001$). The NBD mean for males before and after intervention were 8.92 ± 0.88 and 2.69 ± 0.59, respectively ($P < 0.0001$). As Table 3 shows, the mean of CAS scores reduced significantly after intervention ($P < 0.0001$). The CAS mean for males were 3.36 ± 0.31 and 1.60 ± 0.26, before and after intervention, respectively ($P < 0.0001$), and for females, were 3.27 ± 0.69 and 2.36 ± 0.77, respectively ($P < 0.033$) [Table 3].

We considered the scores of NBD as two categorizes "0–9" and "≥10." There were also significant differences in the score of NBD before and after intervention ($P < 0.0001$) based on these categories. The percentage of NBD <9 changed from 53.1% before treatment to 91.8% after intervention in males ($P < 0.0001$) and from 54.5% to 81.8% in females ($P = 0.25$) [Table 4].

The mean and maiden of NBD and CAS scores in patients with different level of injury are presented in Table 5. The results showed that there was a significant difference in terms of NBD scores in patients with different levels of injury before treatment ($P < 0.01$). As shown in Table 5, patients with lumbar injury had less NBD than other injures before intervention (mean ± SE: 4.57 ± 1.47) that was not significant after treatment. However, in patients with thoracic injury, the mean of NBD, before and after treatment was 10.52 ± 0.88 and 3.13 ± 0.78, respectively ($P < 0.0001$). No significant difference was found among patients with different levels of injury in terms of CAS mean before and after intervention. However, in patients with thoracic injury, the mean of CAS, before and after treatment was 3.56 ± 0.30 and 1.81 ± 0.32, respectively ($P < 0.0001$). In addition, changes of CAS scores before and after intervention were statistically significant in lumbar level ($P = 0.019$; 2.43 ± 0.58 and 1.36 ± 0.53, for before and after treatment, respectively) [Table 5].

Table 6 shows the cross-tabulation of the NBD categories based on before and after intervention by level of injury. There was a significant difference in the terms of NBD before and after intervention ($P < 0.0001$) in patients with thoracic injury. The percentage of NBD <9 changed from 41.9% before treatment to 90.3% after intervention for this group [Table 6].

The mean and maiden of the NBD and CAS scores in different age groups are presented in Table 7. The results showed that patients with 40–50 years old had more NBD than other age groups before and after intervention (mean ± SE: 9.38 ± 1.37 and 4.44 ± 1.26, before and after intervention, respectively), but this difference was not statistically significant. In addition, no significant difference was found among patients with different age groups in terms of CAS mean before and after intervention [Table 7].

Comparison of the NBD categories before and after intervention by age groups is presented in Table 8. There was a significant difference in the terms of NBD before and after intervention ($P < 0.016$) in patients with 30–40 years old. The percentage of NBD <9 changed from 47.1% before treatment to 88.2% after intervention for this age group [Table 8]. These percentages changed from 54.5 and 50 before intervention to 90.9 and 81.3 after intervention in patients with <30 and 40–50 years old, respectively [Table 8].

Table 2: The constipation assessment scale before and after intervention

Symptoms	No problem (%)	Some problem (%)	Severe problem (%)	*P*
Abdominal distension or bloating				
Before	35 (57.4)	24 (39.3)	2 (3.3)	<0.001
After	50 (82)	11 (18)	0	
Increased amount of gas passed rectally				
Before	25 (41)	34 (55.7)	2 (3.3)	0.014
After	54 (88.5)	6 (9.8)	1 (1.6)	
Less frequent bowel movements				
Before	5 (8.2)	44 (72.1)	12 (19.7)	<0.001
After	39 (63.9)	19 (31.1)	3 (4.9)	
Oozing liquid stool				
Before	54 (88.5)	7 (11.5)	0	<0.001
After	56 (91.8)	5 (8.2)	0	
Rectal pain with bowel movement				
Before	38 (62.3)	23 (37.7)	0	0.007
After	52 (85.2)	9 (14.8)	0	
Small volume of stool				
Before	27 (44.3)	34 (55.7)	0	0.021
After	55 (90.2)	6 (9.8)	0	
Unable to pass stool				
Before	26 (42.6)	34 (55.7)	1 (1.6)	0.002
After	49 (80.3)	12 (19.7)	0	

Values are *n* (%)

Table 3: Neurogenic bowel dysfunction and constipation assessment scale scores before and after intervention by sex

	Total sample		Males		Females	
	NBD score	CAS score	NBD score	CAS score	NBD score	CAS score
Pretreatment						
Mean±SE	8.95±0.78	3.34±0.28	8.92±0.88	3.36±0.31	9.10±1.69	3.27±0.69
Median (IQR)	8 (3.3-15)	3 (2-5)	8 (3-15)	3 (1.75-5)	9 (6-15)	3 (2-4)
Posttreatment						
Mean±SE	3.03±0.57	1.74±0.25	2.69±0.59	1.60±0.26	4.55±1.70	2.36±0.77
Median (IQR)	1 (1-3)	1 (1-2)	1 (1-3)	1 (1-2)	2 (1-9)	2 (0-4)
Change	−5.92±0.76	−1.61±0.22	−6.22±0.88	−1.76±0.25	−4.55±1.20	−0.91±0.37
*P**	<0.0001	<0.0001	<0.0001	<0.0001	0.004	0.033

**P* values resulted from paired *t*-test. NBD=Neurogenic bowel dysfunction, CAS=Constipation assessment scale, SE=Standard error, IQR=Interquartile range

Table 4: Comparison of the neurogenic bowel dysfunction scores before and after intervention by sex

	NBD score	Total sample		Males		Females	
		n (%)	*P*	*n* (%)	*P*	*n* (%)	*P*
Pretreatment	0-9	32 (53.3)	<0.0001	26 (53.1)	<0.0001	6 (54.5)	0.25
	≥10	28 (46.7)		23 (46.9)		5 (45.5)	
Posttreatment	0-9	54 (90.0)		45 (91.8)		9 (81.8)	
	≥10	6 (10.0)		4 (8.2)		2 (18.2)	

P values resulted from McNemar test. NBD=Neurogenic bowel dysfunction

Table 9 shows the Pearson's correlation coefficients between age, the NBD, and CAS scores before and after intervention by sex. The NBD scores correlated significantly with CAS scores before ($r = 0.79$; $P < 0.01$) and after (0.87; $P < 0.01$) intervention in total sample. These coefficients changed from 0.76 ($P < 0.01$) and 0.95 ($P < 0.01$) before intervention to 0.85 ($P < 0.01$) and 0.91 ($P < 0.01$) after intervention for males and females, respectively. The correlations between the NBD scores before and after treatment were 0.40, 0.33 and 0.75 for total sample, males and females, respectively ($P < 0.01$). In addition, the correlations between the CAS scores before and after intervention were 0.66, 0.61 and 0.88 for total sample, males, and females, respectively ($P < 0.01$). We found no evidence of an association between age with the NBD and CAS scores, before and after intervention [Table 9].

Table 5: Changes on mean and median of neurogenic bowel dysfunction and constipation assessment scale after 6 weeks of follow-up by level of injury

	Level of injury					
	Cervical	Thoracic	Lumbar	Thoracic and lumbar	*P**	η^2
NBD						
Pretreatment						
Mean±SEM	7.17±2.47	10.52±0.88	4.57±1.47	11.13±2.70	0.008	0.19
Median (range)	7 (1-17)	10 (1-17)	1 (1-17)	16 (1-17)	-	-
Posttreatment						
Mean±SEM	2.83±1.50	3.13±0.78	2.64±1.30	3.75±1.93	0.956	0.006
Median (range)	1.5 (0-10)	1 (0-17)	2 (0-19)	2.5 (0-17)	-	-
Change	−4.33±2.75	−7.39±0.92	−1.93±1.07	−7.38±2.73	-	-
*P***	0.176	<0.0001	0.095	0.031	-	-
CAS						
Pretreatment						
Mean±SEM	2.67±0.56	3.56±0.30	2.43±0.58	4.50±1.36	0.141	0.09
Median (range)	2.5 (1-5)	3 (1-7)	1.5 (0-8)	5 (0-10)	-	-
Posttreatment						
Mean±SEM	1.50±0.76	1.81±0.32	1.36±0.53	2.50±0.98	0.617	0.031
Median (range)	1 (0-5)	1 (0-7)	1 (0-8)	1.5 (0-8)	-	-
Change	−1.17±0.54	−1.75±0.28	−1.07±0.40	−2.00±0.96	-	
P†	0.084	0.0001	0.019	0.077	-	

*Resulted from ANOVA, **Resulted from paired *t*-test. †Resulted from paired *t*-test. NBD=Neurogenic bowel dysfunction, CAS=Constipation assessment scale, SEM=Standard error of mean, ANOVA=Analysis of variance. *P* values < 0.05 was considered statistically significant

Table 6: Comparison of the neurogenic bowel dysfunction scores before and after intervention by level of injury

	NBD score	Level of injury							
		Cervical		Thoracic		Lumbar		Thoracic and lumbar	
		n (%)	*P*	*n* (%)	*P*	*n* (%)	*P*	*n* (%)	*P*
Pretreatment	0-9	4 (66.7)	>0.99	13 (41.9)	<0.0001	12 (85.7)	>0.99	3 (37.5)	0.125
	≥10	2 (33.3)		18 (58.1)		2 (14.3)		5 (62.5)	
Posttreatment	0-9	5 (83.3)		28 (90.3)		13 (92.9)		7 (87.5)	
	≥10	1 (16.7)		3 (9.7)		1 (7.1)		1 (12.5)	

P values resulted from McNemar test. NBD=Neurogenic bowel dysfunction

Table 7: Comparison of the neurogenic bowel dysfunction and constipation assessment scale scores before and after intervention in different age groups

	Age				*P**	η^2
	<30	30-40	40-50	>50		
NBD						
Pretreatment						
Mean±SEM	9.36±1.80	9.35±1.60	9.38±1.37	7.81±1.59	0.861	0.013
Median (range)	8 (1-17)	10 (1-17)	9.5 (1-17)	6 (1-17)	-	-
Posttreatment						
Mean±SEM	2.64±1.47	3.30±1.30	4.44±1.26	1.63±0.26	0.343	0.057
Median (range)	1 (0-17)	2 (0-19)	2.5 (0-17)	1 (0-3)	-	-
CAS						
Pretreatment						
Mean±SEM	2.82±0.48	3.24±0.52	4.18±0.62	2.94±0.54	0.306	0.061
Median (range)	2 (1-7)	4 (0-8)	4 (0-10)	2.5 (0-7)	-	-
Posttreatment						
Mean±SEM	1.27±0.59	1.53±0.50	2.53±0.58	1.44±0.29	0.272	0.066
Median (range)	1 (0-7)	1 (0-8)	2 (0-8)	1 (0-4)	-	-

*Resulted from ANOVA. ANOVA=Analysis of variance, NBD=Neurogenic bowel dysfunction, CAS=Constipation assessment scale, SEM=Standard error of mean

Table 8: Comparison of the neurogenic bowel dysfunction scores before and after intervention by level of injury

	NBD score	Age							
		<30		30-40		40-50		>50	
		n (%)	*P*	*n* (%)	*P*	*n* (%)	*P*	*n* (%)	*P*
Pretreatment	0-9	6 (54.5)	0.125	8 (47.1)	0.016	8 (50.0)	0.063	10 (62.5)	-
	≥10	5 (45.5)		9 (52.9)		8 (50.0)		6 (37.5)	
Posttreatment	0-9	10 (90.9)		15 (88.2)		13 (81.3)		16 (100)	
	≥10	1 (9.1)		2 (11.8)		3 (18.8)		-	

P values resulted from McNemar test. NBD=Neurogenic bowel dysfunction

Table 9: Pearson's correlation coefficients between age, the neurogenic bowel dysfunction and constipation assessment scale scores before and after intervention by sex

	Total sample				Males				Females			
	NBD (pre)	CAS (pre)	NBD (post)	CAS (post)	NBD (pre)	CAS (pre)	NBD (post)	CAS (post)	NBD (pre)	CAS (pre)	NBD (post)	CAS (post)
CAS (pre)	0.789*	1			0.760*	1			0.945*	1		
NBD (pre)	0.403*	0.589*	1		0.325*	0.523*	1		0.749*	0.864*	1	
CAS (post)	0.370*	0.658*	0.866*	1	0.274	0.613*	0.845*	1	0.778*	0.877*	0.905*	1
Age	−0.099	0.022	−0.061	0.083	−0.053	0.078	−0.021	0.118	−0.373	−0.276	−0.190	−0.006

*Correlation is significant at the 0.01 level. NBD=Neurogenic bowel dysfunction, CAS=Constipation assessment scale

Our analysis did not show any difference in the effect of traditional wood toothbrush in male and female patients (not shown).

Discussion

We investigated the effect of traditional wooden toothbrush on constipation in SCI patients. Our results demonstrated that the use of wooden toothbrush leads to improving all constipation symptoms in CAS scale, including rectal pain, bowel movement, and inability to pass stool.

Colorectal dysfunction and constipation are common problems in SCI patients, and their colorectal defecating function is weak.[15,16] The studies showed that sacral nerves stimulation was a therapeutic option for the treatment of chronic and severe constipation and some of fecal incontinence.[17,18] Parasympathetic nerves supply intrinsic innervations of the GI tract which has direct effects on its peristaltic function.[19] According to some studies, the stimulation of sacral nerves (S2-S3-S4) and vagus nerve can be an alternative approach in the treatment of constipation.[20,21] Kojima *et al*.[22] reported that vagus nerve was very important in GI disorders after gastrectomy. They showed vagus nerve preservation combined with gastrectomy prevented some postgastrectomy syndrome.

Trigeminal sensory (CN5) is a cranial nerve which is distributed under the skin of face and the anterior part of head, and under the epithelium of the mouth and nasal cavities, and is responsible for conscious sensation in head and neck, including pain and temperature. It is also responsible for most muscles' unconscious proprioception sensation in the whole head and neck area. On the other hand, the vagus motor (CN10) cranial nerve distributed in GI tract, from pharynx to splenic flexure of the colon, and is responsible for motor activity of this part of the gut. These two widespread cranial nerves are thought to be connected by MLF, which is a narrow band of nerve fibers and are present predominantly in cervical spinal cord and the whole brain stem, bilaterally adjacent to cord central canal and cerebral canal, respectively. MLF actually connects vestibular nuclei with extraocular muscles, in the brain stem, and we thought it might connect CN5 and CN10 nuclei, as well.[23-26] Therefore, we hypothesized that any stimulation of CN5 nerve endings, including periodontal tissue, will stimulate vagus nerve endings, through MLF (by what we called "trigemino colic Reflex"), and will finally increase peristaltic waves and lead to defection, micturition, or other GI reflexes such as belching.

Conclusions

Constipation and colorectal dysfunction are the cause of distress and have a negative impact on the quality of life among SCI patients. This significant problem puts the burden of finding an effective treatment for this illness on the shoulders of physicians. The results of our study proved to be a choice therapeutic management for this problem.

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Conflicts of interest

There are no conflicts of interest.

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