

Colon Transit Time According to Physical Activity Level in Adults

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Background/Aims

Physical activity (PA) is associated with a reduced risk of colorectal cancer. Thus, we examined the colon transit time (CTT) according to the physical activity level (PAL) in Korean adults.

Methods

The study subjects were 49 adults: 24 males and 25 females. The subjects used an accelerometer for 7 consecutive days to measure the 1-week PAL. The subjects took a capsule containing 20 radio-opaque markers for 3 days. On the fourth day, a supine abdominal radiography was performed. According to the total activity count of all study subjects, the upper 25%, middle 50% and lower 25% were classified into the high (H), moderate (M) and low (L) physical activity (PA) groups, respectively.

Results

The total CTT was significantly longer in the female (25.8 hours) than in the male subjects (7.4 hours) ($P = 0.002$). In regard to difference on PAL, although there was no significant difference among the male subjects, the right CTT in the female subjects was significantly shorter in H group than in M group ($P = 0.048$), and the recto-sigmoid CTT was significantly shorter in H group than in L group ($P = 0.023$). Furthermore, there were significant differences in total CTT between L and M groups ($P = 0.022$), M and H groups ($P = 0.026$) and between L and H groups ($P = 0.002$).

Conclusions

The female, but not male, subjects showed that moderate and high PAL assisted colon transit.

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Key Words

Accelerometer; Adult; Colon transit time; Physical activity; Radio-opaque marker

Introduction

According to studies which have recently been performed in Western countries where the incidence of colorectal cancer is rel-

atively higher, the risk of developing colorectal cancer is decreased with increasing workload and level of physical activity (PA) during leisure time. Colorectal cancer is the third most prevalent cancer worldwide with an incidence of 9.8% and a mortality of 8.0%.¹ The recognized risk factors include westernized

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eating habits, obesity, drinking alcohol, insufficient PA level (PAL) and genetic factors.² The inhibition of colorectal cancer by PA is based on the following 2 mechanisms. Peristalsis of the intestines is activated by PA and this eventually shortens the colon transit time (CTT). This reduces the time during which the carcinogens within the colon are in contact with the intestinal mucosa, thereby suppressing any carcinogenesis. Otherwise, peristalsis of the intestines is promoted or increased by the increased synthesis of prostaglandin within the body.³ Hormones involved in the synthesis of bile acid, cholesterol converted into the bile acid in the liver, and substances involved in tumor growth, such as interleukin-1, are affected by physical exercise.⁴⁻⁶ According to White et al,² regarding the correlation between PA and the pathogenesis of colorectal cancer, the risks of developing colorectal cancer were decreased in women aged 45 years or older who did physical activities for more than 4 hours a week, including walking or riding a bicycle, as compared with those who maintain daily lives in a sitting position. They also reported that high-impact PA was more effective than light PA in reducing the occurrence of colorectal cancer. In addition, case-control studies and cohort ones have also reported that insufficient PA raised the incidence of colorectal cancer.^{5,7} The importance of PA in the prevention of colorectal cancer has thus been well documented. To date, however, few studies have examined the effects of level or intensity of PA on CTT. Radio-opaque markers have frequently been used to measure colorectal motor function.^{8,9} Accordingly, in the current study, CTT was measured by using a radio-opaque marker to identify the dependence of CTT on the level or intensity of PA. The study results were used to determine the appropriate PAL for the healthy colonic function.

Materials and Methods

Participants

The study subjects were 49 adults including 24 males and 25 females and the mean age was 37.4 years with a range of 20-59 years who voluntarily gave written informed consent. The study was approved by the Institutional Review Board of Seoul National University (IRB No. 2010/1006). Of all potential subjects, those with a possible restriction in normal PA, cardiovascular or orthopedic diseases which might affect CTT, woman in the menstrual period, inability to take drugs due to functional stomach diseases, a prescription course of anti-constipation drugs and diabetes mellitus or hypertension were ex-

cluded from the current analysis.^{10,11}

Measurement of Physical Characteristics

Bioelectrical impedance analysis (Inbody, Biospace, Seoul, Korea) was used in the measurement of height, weight and body mass index (BMI). Blood pressure was measured using a sphygmomanometer (SPRIT CK-101, Sankei, Japan) in the prone position after a 5-minute rest. Attempts were made to rule out any extrinsic factors that might affect the blood pressure, such as temperature, degree of PA, smoking and diet.¹⁰

Measurement of Physical Activity Level

PAL was measured over a 1-week period using an accelerometer (Accelerometer, Mini mitter, Chicago, USA). For accurate PA measurement, the study subjects were advised to perform their daily physical activities freely. The accelerometer was attached to the iliac crest using a belt. Prior to the measurement, the age, sex, height and weight were entered. The total energy expenditure, activity energy expenditure, and time of activity depending on the PA intensity and frequency were individually measured according to the time. The results were automatically stored. Using the recorded data, the energy expenditure was calculated based on Mifflin's formula to calculate the basal metabolic rate.¹² To differentiate the PA intensity according to the total activity count of all study subjects, the upper 25%, middle 50% and lower 25% were classified into the high (H), moderate (M) and low (L) PA groups, respectively.

Measurement of Colon Transit Time

CTT was measured using a multiple marker technique with a radio-opaque marker. The subjects took one capsule containing 20 radio-opaque markers at the same time every day for 3 days (KolomarkTM, MI Tech, Pyeongtaik, Korea). On the fourth day following the first administration, a supine abdominal radiography was performed. Mean CTT (hour) was calculated by counting the number of radio-opaque markers that were left in the total colon and the segment of the colon and then multiplying it by 1.2.^{10,11}

Statistical Methods

The study data, expressed as mean \pm standard deviation, were analyzed using SPSS PC+ for Windows version 18.0 (SPSS Inc., Chicago, IL, USA). To analyze the difference in CTT according to PAL between the 3 groups, one-way ANOVA was performed. LSD post-hoc analysis was performed

on the variables showing a statistically significant difference. A value of $P < 0.05$ was considered statistically significant.

Results

Physical Characteristics

The physical characteristics of the study subjects are shown in Table 1. The mean age was 39.7 and 35.3 years in the male and female subjects, respectively. The variables associated with physical characteristics, such as the height, weight, BMI and blood pressures, were significantly higher in the male subjects than in the female subjects ($P < 0.001$).

Level and Intensity of Physical Activity

The level and intensity of PA in the male and female subjects are shown in Table 2. The values of total energy expenditure ($P < 0.001$), total activity count ($P = 0.003$), energy expenditure of light intensity activity ($P = 0.007$) and energy expenditure of moderate intensity activity ($P < 0.001$) were significantly higher in the male subjects than in the female subjects.

Colon Transit Time According to Physical Activity Level

The mean total CTT (TCTT) was 16.8 hours, 25.8 hours in the female subjects and 7.4 hours in the male subjects. This gender difference was statistically significant ($P = 0.002$). Although there was no significant difference among the L, M and H groups in the male subjects, TCTT in H group of female subjects was significantly shorter than in L and M group. And also, TCTT in M group was shorter than in L group (Table 3).

The results for segmental CTT according to PAL are shown in Table 3. Following a comparison of the segmental CTT between the male and female subjects, right CTT (RCTT) ($P =$

0.023) and recto-sigmoid CTT (RSCTT) ($P = 0.004$) were more prolonged in the female subjects than in the male subjects. In regard to the difference depending on PAL in the female subjects, RCTT in H group was significantly shorter than that in M group ($P = 0.048$). In addition, RSCTT in H group was significantly shorter than in L group ($P = 0.023$).

Discussion

The mean TCTT of 16.8 hours, 7.4 hours in the male subjects and 25.8 hours in the female subjects, was shorter than the 35 hours reported for Caucasian people by Martelli et al.¹³ and the 33.4 hours reported by Chaussade et al.¹⁴ In addition, these study results are also shorter than the 21 hours for male subjects and 28 hours for female subjects reported for Asian people by Chan et al.^{11,15} This significant difference for the mean CTT of the male subjects compared to previously reported literature values could not be explained, although possible reasons include differences in occupational characteristics, eating habits, living patterns and genetic factors.

The previously reported factors affecting CTT include age, sex, BMI, dietary fiber, water intake and living habits.⁹ However, controversy continues as to the effects of these variables on CTT. In a literature review on the factors affecting CTT, CTT was relatively shorter in male subjects.^{9,16} According to 2 other studies, however, this gender difference was not statistically significant.^{17,18} In our results, TCTT, RCTT and RSCTT were significantly shorter in the male subjects than in the female subjects. These results were analogous to reports that left CTT based on the segment was significantly shorter in male subjects than in female subjects⁹ and that RCTT was significantly longer in female subjects.¹⁹⁻²¹ In women, the prevalence of constipation is relatively higher. In association with this, although it is presumed that CTT might be prolonged during the luteal phase where the

Table 1. Physical Characteristics of the Participants

	Male (n = 24)	Female (n = 25)	Total (N = 49)	P-value
Age (yr)	39.7 ± 10.1	35.3 ± 5.6	37.4 ± 8.3	0.068
Height (cm)	171.4 ± 6.1	159.8 ± 5.7	165.5 ± 8.3	< 0.001
Weight (kg)	73.6 ± 11.6	56.3 ± 6.4	65.5 ± 12.6	< 0.001
BMI (kg/m ²)	24.0 ± 2.3	21.9 ± 2.2	23.0 ± 2.4	0.004
SBP (mmHg)	117.8 ± 7.8	106.4 ± 9.5	111.3 ± 10.4	< 0.001
DBP (mmHg)	77.9 ± 8.8	65.6 ± 8.2	71.6 ± 10.5	< 0.001

BMI, body mass index; SBP, systolic blood pressure; DBP, diastolic blood pressure. Values are mean ± SD. P-values are the difference between the male and female groups.

Table 2. Physical Activity Level and Intensity in Male and Female Subjects

	Male (n = 24)				Female (n = 25)			
	L	M	H	Total	L	M	H	Total
TEE (kcal)	452.4 ± 85.7	697.4 ± 142.8	767.6 ± 128.0	653.7 ± 172.8 ^a	247.9 ± 63.1	357.8 ± 93.5	536.0 ± 143.6	381.3 ± 147.3
TAC (count)	155,774 ± 16,907	242,869 ± 33,888	345,714 ± 38,175	246,807 ± 75,167 ^b	103,736 ± 14,872	164,817 ± 18,033	262,125 ± 93,899	177,404 ± 76,998
EEL (kcal)	126.5 ± 30.4	159.4 ± 44.0	137.8 ± 33.7	145.8 ± 39.8 ^c	97.8 ± 36.4	105.5 ± 36.4	136.3 ± 56.3	112.3 ± 43.8
EEM (kcal)	314.7 ± 51.4	517.7 ± 121.8	583.1 ± 143.3	483.3 ± 150.9 ^d	165.9 ± 31.2	270.4 ± 58.7	372.4 ± 107.3	273.9 ± 102.0
EEV (kcal)	11.1 ± 10.3	20.2 ± 31.1	46.6 ± 60.0	24.5 ± 38.1	0.8 ± 1.0	6.8 ± 18.5	27.2 ± 57.4	11.1 ± 33.0

L, low physical activity group; M, moderate physical activity group; H, high physical activity group; TEE, total energy expenditure; TAC, total activity count; EEL, energy expenditure of light intense activity; EEM, energy expenditure of moderate intense activity; EEV, energy expenditure of vigorous intense activity. Values are mean ± SD. Difference between the male and female groups at TEE (^a $P < 0.001$), TAC (^b $P = 0.003$), EEL (^c $P = 0.007$) and EEM (^d $P < 0.001$).

concentration of progesterone is elevated based on the menstrual cycle, some other studies have reported an absence of any correlation between the menstrual cycle and CTT.^{16,22}

Controversy also continues as to the effect of PAL on CTT. According to several reports, PA or exercise had no effect on CTT.^{9,19-21,23} In addition, significant differences have been reported for the effects of living and eating habits in patients with chronic constipation, although exercise caused no significant difference in CTT.^{9,23} Some studies have reported that PAL affected the body constituents and eating habits, and hence CTT.²³⁻²⁵ In the current study, there was a significant difference among the 3 subgroups of the female subjects. Furthermore, RCTT differed significantly between M and H groups. This might be not only because most of the studies chose PAL as a control variable but also because few quantitative studies have examined PAL. The current study was limited by the small sample size, which prevents any generalization of the study results, so further studies should be conducted with more variables and subjects.

Most of the health benefits attributed to increased PA have been reported to improve the physical fitness associated with health.²⁵ Thus, chronic diseases such as hypertension, obesity and osteoporosis can be prevented or treated. In addition, the effects of PA on colorectal cancer, gastrointestinal symptoms and constipation have also been reported.^{25,26} Physical inactivity is an independent factor that is associated with the pathogenesis of type 2 diabetes mellitus, which can increase the incidence of type 2 diabetes mellitus in normal weight people and obese people.^{27,28} It has been reported that regular PA changes the distribution of body fat while also decreasing the body weight, and it can thereby contribute to the prevention of adult diseases.²⁴ Living and eating habits, which account for a major part of the maintenance of health, along with exercise, not only activate physical development but also resolve the defecation symptoms by ensuring a correct diet with balanced nutrients.^{24,26}

The previous studies showed that women had lower amount of PA than man and tend to be sedentary. Women with lesser experience on PA showed more positive effect through the PA. This study also considered that sedentary women showed a positive tendency of the CTT through the intensive PA and men also needed to have more amount of intensive activity for CTT.

The current study was conducted to examine the effects of PAL on CTT. Of the powerful variables associated with CTT, however, those associated with food intake (ie, dietary fibers and water) were not included in the current study. This was a limi-

Table 3. Segmental Colon Transit Time According to Physical Activity Level

	Male (n = 24)				Female (n = 25)			
	L	M	H	Total	L	M	H	Total
RCTT (hr)	4.0 ± 6.5	4.2 ± 6.7	1.4 ± 1.4	3.4 ± 5.7 ^a	10.4 ± 10.6	14.5 ± 15.2 ^b	2.4 ± 4.4	10.1 ± 12.7
LCTT (hr)	0.8 ± 0.9	1.0 ± 2.7	1.0 ± 0.9	0.9 ± 2.0	3.2 ± 5.8	0.7 ± 1.4	0.6 ± 1.8	1.3 ± 3.1
RSCCTT (hr)	4.4 ± 9.0	5.2 ± 7.8	2.8 ± 3.2	4.4 ± 7.1 ^c	21.8 ± 14.4	15.3 ± 13.8	3.8 ± 7.0 ^d	14.0 ± 13.8
TCTT (hr)	9.2 ± 11.2	7.6 ± 10.8	5.2 ± 4.0	7.4 ± 9.3 ^e	35.4 ± 27.9 ^f	30.5 ± 22.1 ^g	2.8 ± 3.4 ^h	25.8 ± 24.1

L, low physical activity group; M, moderate physical activity group; H, high physical activity group; RCTT, right colon transit time; LCTT, left colon transit time; RSCCTT, recto-sigmoid colon transit time; TCTT, total colon transit time.

Values are mean ± SD. Difference between the male and female groups at RCTT (^a*P* = 0.023), RSCCTT (^c*P* = 0.004) and TCTT (^e*P* = 0.002); difference between the L and M at TCTT (^f*P* = 0.022) in female subjects; difference between the M and H at RCTT (^b*P* = 0.048) and TCTT (^g*P* = 0.026) in female subjects; difference between the L and H at RSCCTT (^d*P* = 0.023) and TCTT (^h*P* = 0.002) in female subjects.

tation of the current study.

Based on these results, mean CTT was 16.8 hours in 49 adults. The female, but not male, subjects showed significant relations between PAL and CTT. Finally, the female subjects showed a tendency, for moderate and high PAL to help colon transit.

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