Differentiation of Prolonged Colonic Transit Using Scintigraphy with Indium-111-Labeled Polystyrene Pellets

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Prolonged colonic transit can be caused either by slow transit constipation or by pelvic outlet obstruction needing different therapeutic regimes. The aim of this study was to prove the value of scintigraphic assessment. **Methods:** Colon scintigraphy was performed in 32 patients (28 women, 4 men; age range 8–68 yr) with idiopathic constipation at 8, 24 and 48 hr in ventral and dorsal projection after oral administration of a pH-sensitive, methacrylate-coated capsule of nonresorbable ^{111}In-labeled polystyrene (cathion exchanger) micropellets (3.5 MBq/capsule). The geometric center (GC) as the sum of products of colon segment activity and colon segment number (1 = colon ascendens; 2 = transverse colon; 3 = colon descendens; 4 = rectosigmoid colon; and 5 = stool) dividing by the total counts was used to determine the velocity of colonic transit at least at 24 hr as the proximal colonic emptying (PCE) rates. Stool activity was evaluated indirectly as decay-corrected colon activity loss between two examinations. Results were compared with data obtained from 22 healthy subjects. **Results:** Twenty-six patients had a significant prolongation of colonic transit after 24 and 48 hr (the 95% confidence interval of the patient's GC showed no overlap to the 95% confidence interval of GC calculated from 22 healthy controls as normal range) revealing slow transit constipation. Six patients had normal or accelerated transit (GCs and PCE rates) up to the rectum but delayed rectal emptying indicating pelvic outlet obstruction. **Conclusion:** By the help of this method it was possible to differentiate the two subtypes of colon transit prolongation by use of the reported scintigraphic technique, which leads to different therapeutic management of the patients. Compared with x-ray methods (Hinton test), this method has the capability of a continuous observation of colonic transit without increasing radiation exposure.

Key Words: colon transit; constipation; scintigraphy; proximal colonic emptying

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The clinical syndrome of constipation can be caused by prolonged gastric emptying, pathologic alterations of jejuno-ileal transit or delayed colonic transport. Exact localization of prolonged transit gives a hint on the basic disease. Prolongation of colonic transit can be caused either by slow transit constipation or by pelvic outlet obstruction. The differentiation between these two subtypes is necessary for prescribing the appropiate therapy. For example, bio-feedback therapy (training of rectal emptying) for patients having pelvic outlet obstruction and changes of alimentation or medication in patients with slow transit constipation.

The aim of this study was to test whether the method of selective scintigraphic assessment of colon transit using ^{111}In-labeled polystyrene micropellets is useful for this differentiation in clinical practice (*1–6*).

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MATERIALS AND METHODS

Patients

Thirty two patients (28 women, 4 men; mean age ± 1 s.d. = 42 ± 15 yr; age range 8–68 yr) with clinical suspicion of idiopathic constipation were entered into this study. The time intervals between defecation must exceed 5 days as criterion for entering the study. Data collected in 22 healthy subjects served as a reference for normals.

Capsule Preparation

The day before examination, about 4.5 MBq of ^{111}In were adsorbed on polystyrene micropellets (cathion exchanger), resulting in 3.5 MBq at the day of administration. A fine suture was fixed at one end of the capsule before filling of the capsule with the micropellets. After closing the filled capsule, it was dipped into liquid methacrylate. This pH-sensitive coating (methacrylate) protects the capsule from dissolving until arrival in the cecum. Then the capsule was suspended by the fixed suture until time of application (the following morning). Before application, the suture was cut near to the capsule. This technique of preparation has been developed by von der Ohe and Camilleri (*6*).

Imaging

Planar scintigrams (ventral and dorsal images, time of acquisition = 120 sec) were obtained at 8, 24 and 48 hr after administration of the capsule in upright patient position.

Quantification

Each colonic segment's activity (SA) was defined on the scintigraphic images by drawing irregular regions of interest (ROIs) on the ventral and dorsal views and then calculating the geometric means for each segment. The geometric means were used instead of the arithmetic means with respect to the exponential attenuation of the activity in the tissue of the patient. If the patient had a bowel movement between two imaging sessions, excreted activity was calculated as the decay-corrected differences between expected and measured bowel activities. For determining the velocity of colonic transit up to the time points of measurement (8, 24 and 48 hr), the geometric center (GC) is calculated by adding the products of SA (geometric means) and segment number (SN) (SN 1 = colon ascendens; SN 2 = transversum; SN 3 = descendens; SN 4 = rectosigmoid; SN 5 = stool) in each colon segment with subsequent division by the total activity:

$$GC = \frac{(SN\ 1 \times SA\ 1) + \ldots + (SN\ 5 \times SA\ 5)}{SA1 + \ldots + SA5}. \quad \text{Eq. 1}$$

A low value for the GC at a certain time point indicates a prolonged transit, a high value to the contrary.

Furthermore, the proximal colonic emptying (PCE) was determined at 24 hr according to the formula

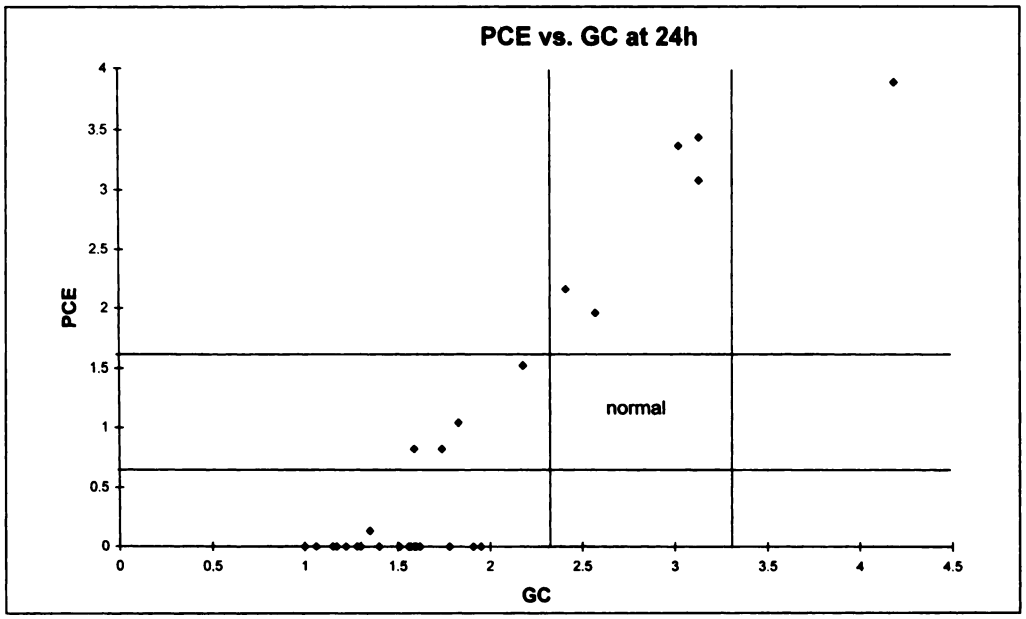

FIGURE 1. Proximal colonic emptying (PCE) versus geometric center (GC) at 24 hr with marked normal ranges of both parameters. PCE rates seem to be more sensitive than determination of GC in detection of accelerated colonic transit. Several patients with normal GC had elevated PCE rates (and other ones with diminished GC normal PCE, respectively). Correlation coefficient = 0.8706.

$$PCE = \frac{(DSC + RSC + STO) \times 100}{(ASC + TRA + DSC + RSC + STO) \times 24\ hr}\ [\%/hr]. \quad \text{Eq. 2}$$

ASC = ascending; TRA = transversal; DSC = descending; RSC = rectosigmoid colon; STO = stool):

A 100% retention in the proximal colon yields a PCE = 0 and a complete emptying of the proximal colon yields a PCE $\approx$ 4. As mentioned above, stool activity was calculated indirectly as decay-corrected loss of activity between two examinations, the activities of the other colon segments were calculated as geometric means of the irregular ROIs in anterior and posterior views. According to Vassallo et al. (*5*), 1.1% $\pm$ 0.5%/hr was taken as reference for PCE.

At times, small amounts of activity could be registered only in one projection (ventral or dorsal). If the counting rate in the projection without activity is set to zero, the value for geometric mean would be zero as well. In these cases, the ROI of the image with activity would be applied as the mirror image on the analogous region in the other projection. Because only scattered activity is present is this mirrored ROI, this leads to a registration of low amounts of activity and, therefore, the values for the geometric means are closer to the real situation (presence of a little filling) than if they are zero. Such problems would disappear if the arithmetric mean is calculated but this is not possible with respect to the attenuation correction.

RESULTS

In all cases, a complete dissolution of the capsule could be stated in the terminal ileum or caecum after 24 hr. The GC and PCE values showed a good correlation (correlation coefficient = 0.8706) and are plotted in Figure 1. The simultaneous normal range "normal area" of both variables is marked with "normal" in this graph. Patients with very slow transit had no emptying of the proximal colon (PCE = 0). Patients with PCE rates exceeding 0 can be differentiated more exactly using the PCE ranges as reference because more patients had pathologically elevated PCE rates than GCs. This was the reason for judging patients to have a pelvic outlet obstruction by means of the PCE rates.

A majority (n = 26) of patients had diminished GC and PCE rates at 24 hr (Table 1). Six patients with elevated PCE rates at 24 hr had normal (n = 5) or elevated (n = 1) GCs at 24 hr. These six patients were considered to have a pelvic outlet obstruction, which was confirmed by anorectal manometry and defecography.

In Table 2, the results of colonic transit measurement for the slow transit constipation and pelvic outlet obstruction groups are given compared with the values of the reference group. Because of the low number of patients having pelvic outlet obstruction, the best statistical method seems to be the comparison of the confidence intervals (mean $\pm$ 2 $\times$ s.e.m.). Therefore, the Student's t-test should give only a second hint for judging the difference of the GCs from 4 hr to 48 hr and the PCE rates at 24 hr between both groups. Comparing the results at 24 hr of the both groups with the reference collective, the slow transit constipation group indicated both diminished GCs and PCE rates, whereas the pelvic outlet obstruction group showed elevated PCE rates and normal GCs.

Typical findings in scintigraphic assessment of patients with slow transit constipation are demonstrated in Figure 2A-C. The main part of activity remains in the ascending colon and right flexure up to 48 hr. Figure 2D-F shows the corresponding scintigraphic findings of patients with suspicion of pelvic outlet obstruction. In all patients, the dissolution of the capsule could be seen in the acquisition at 24 hr.

DISCUSSION

Causes for constipation are often unknown (*7*). Several drugs such as lactulose (*8*), cisapride (*9*) and some liquids (*10*) can accelerate colonic transit, other ones as morphine (*11*) or verapamil (*12*) can cause transit prolongation [overview in (*6,13,14*)]. Velocity of colonic transit is variable even in normals (*15,16*) and does not depend of lipids (*1,17*). Several diseases, as Crohn colitis (*18*), ulcerative colitis (*19*), irritable colon (*20*), and diabetes (*21*) can affect colonic transit (*22*).

Scintigraphic examinations of colonic transit are described with ^{99m}Tc-diethylenetriamine pentaacetic acid (DTPA) (*23*), ^{111}In-DTPA (*24–26*), ^{99m}Tc-mesalazine (*27*), ^{131}I-cellulose (*28,29*) or ^{99m}Tc-sulfur colloids (*24,30*). The missing encapsulation would lead to an increased radiation exposure of the stomach and small bowel, which are not the subject of examination. Furthermore, some of them are resorbable and cause additionally unnecessary radiation exposure.

The use of nonresorbable ^{111}In-labeled polystyrene micropellets diminishes radiation exposure and is suitable even in constipated patients (*1–6*). Because of the storage function of

TABLE 1
Patient Data Geometric Center (GC) and Proximal Colonic Emptying (PCE) at 24 Hr

Patient no.	Sex	Age (yr)	GC at 24 hr (2.83 ± 0.5*) ↓	GC at 24 hr (2.83 ± 0.5*) =	GC at 24 hr (2.83 ± 0.5*) ↑	PCE at 24 hr (%/hr) (1.1 ± 0.5*) ↓	PCE at 24 hr (%/hr) (1.1 ± 0.5*) =	PCE at 24 hr (%/hr) (1.1 ± 0.5*) ↑	Diagnosis
1	F	24	1.59			0.00			Slow transit constipation
2	F	22	1.59			0.00			Slow transit constipation
3	F	25		3.13				3.44	Pelvic outlet obstruction
4	F	8	1.06			0.00			Slow transit constipation
5	F	54	1.78			0.00			Slow transit constipation
6	F	46	1.30			0.00			Slow transit constipation
7	F	32	1.62			0.00			Slow transit constipation
8	M	46	1.00			0.00			Slow transit constipation
9	F	38	1.83				1.04		Slow transit constipation
10	F	63	1.74				0.82		Slow transit constipation
11	M	66		3.13				3.08	Pelvic outlet obstruction
12	F	35	1.51			0.00			Slow transit constipation
13	F	33	1.56			0.00			Slow transit constipation
14	M	40	1.35			0.13			Slow transit constipation
15	F	21			4.18			3.89	Pelvic outlet obstruction
16	F	63	1.95			0.00			Slow transit constipation
17	F	43	1.59				0.82		Slow transit constipation
18	F	52	2.18				1.52		Slow transit constipation
19	F	31	1.30			0.00			Slow transit constipation
20	F	29	1.15			0.00			Slow transit constipation
21	F	30	1.30			0.00			Slow transit constipation
22	F	46	1.22			0.00			Slow transit constipation
23	F	68	1.60			0.00			Slow transit constipation
24	F	50	1.40			0.00			Slow transit constipation
25	F	33	1.57			0.00			Slow transit constipation
26	F	43		2.57				1.96	Pelvic outlet obstruction
27	F	57	1.91			0.00			Slow transit constipation
28	F	45		2.41				2.16	Pelvic outlet obstruction
29	F	26	1.15			0.00			Slow transit constipation
30	M	51		3.02				3.37	Pelvic outlet obstruction
31	F	58	1.17			0.00			Slow transit constipation
32	F	57	1.28			0.00			Slow transit constipation
Female (n = 28)	Minimum	8.13		1.00			0.00		Slow transit constipation (n = 26)
Male (n = 4)	Mean	41.70		1.80			0.70		Pelvic outlet obstruction (n = 6)
	Maximum	67.78		4.18			3.89		
	s.d.	14.93		0.72			1.21		
	s.e.m.	2.64		0.13			0.21		

*Mean ± 2 s.e.m.

Values below the normal limits are marked with ↓; values within the normal limits are marked with = and values exceeding the normal limits are marked with ↑.

the ascending and transverse colon (*31*), the applied capsule has time enough to dissolve in this region.

To validate this method, the values obtained for colonic transit were compared with the radiopaque marker method using an univariate linear regression analysis (*4*). Hereby, a significant correlation (slope = 0.85, r = 0.73, p = 0.04) could be found. On the other hand, the transit of radiopaque markers was significantly faster than the transport of the activity in that study (Student's t-test, $p < 0.05$).

In this study, a good differentiation between the patients with slow transit constipation and pelvic outlet obstruction of the preselected constipated subjects (criterion for entering the study were intervals of defecation exceeding 5 days) was possible already by 24 hr. Compared with the reference collective of normal subjects, the slow transit constipation group showed diminished GCs and PCE rates at 24 hr, whereas the pelvic outlet obstruction group had an acceleration of colonic transit at 24 hr, which might be explained as a neurologic compensation for the simultaneously delayed rectal emptying. If the presented method should be applied in unselected patients to search for the presence of a constipation at all, delayed images up to 72 hr are necessary in cases of delayed rectal emptying (pelvic outlet obstruction).

Technetium-99m was not used in patients with constipation due to its too short physical half-time. In relation to the desired small amounts of activity, ^{111}In seems to be very expensive. As a proposal for practical use, several patients can be examined on one date. For urgent cases only, the time of capsule preparation can be combined with the delivery of ^{111}In for other examinations (for instance ^{111}In somatostatin imaging), because the amount of necessary activity of ^{111}In is much less compared to those for somatostatin labeling.

Radiation Exposure

In subjects with normal transit, the effective dose is approximately to 1 mSv (*32*). As comparison, one conventional anterior-posterior radiography of the abdominal region during Hinton's test (sensitivity class = S 400; acquisition voltage = 75 kV) yields an effective dose of about 0.3 mSv (*33,34*). If 3–4 radiographs are considered to be necessary during a normal Hinton test, the presented method has a slightly higher radiation exposure.

TABLE 2
Values of Geometric Center (GC) and Proximal Colonic Emptying (PCE) Rate of Patients with Slow Transit Constipation and Pelvic Outlet Obstruction and Normal Controls*

		GC – 4 hr	GC – 8 hr	GC – 24 hr	PCE – 24 hr	GC – 48 hr
Slow transit constipation	n	10	12	26	26	16
	Mean	1.58	1.26	1.51	0.17	0.88
	s.d.	0.25	0.34	0.29	0.40	0.82
	2 × s.e.m.	0.16	0.20	0.11	0.16	0.41
	mean ± 2 s.e.m.	142–1.74	1.06–1.46	1.40–1.62	0.01–0.33	0.47–1.29
Pelvic outlet obstruction	n	3	6	6	6	3
	Mean	1.25	1.68	3.07	2.98	3.27
	s.d.	0.32	0.44	0.62	0.76	1.09
	2 × s.e.m.	0.37	0.36	0.51	0.62	1.26
	mean ± 2 s.e.m.	0.88–1.62	1.32–2.04	2.56–3.58	2.36–3.60	2.01–4.53
Reference group	n	—	22	22	†	22
	mean	—	1.48	2.83	1.1†	4.07
	mean ± 2 s.e.m.	—	1.37–1.59	2.33–3.33	0.60–1.60†	3.51–5.19
Student's t-test	($p_{2\alpha}$)	0.68983	0.07853	0.00093	0.00012	0.24904

*No overlap of the confidence intervals of the slow transit constipation patients comparing to the normal range can be stated at 24 hr and 48 hr, whereas pelvic outlet obstruction patients had normal GC and PCE rates at 24 hr. Significant differences between both groups can be found at 24 hr.

†According to Vassollo et al. (5).

GC – x hr = value of the GC at x hrs.

The Student's t-test compares the slow transit constipation group with the pelvic obstruction group.

CONCLUSION

The reported method seems to be useful in the differentiation of prolonged colon transit and is not invasive. A proximal delay of colon transit (slow transit constipation) can be distinguished from a distal delay (pelvic outlet obstruction), which may lead to different and more individualized therapeutic regimes of the patients. Comparing with roentgenologic assessment (Hinton's test), a continuous registration of colon transit is possible using this scintigraphic method without any increase in radiation exposure.

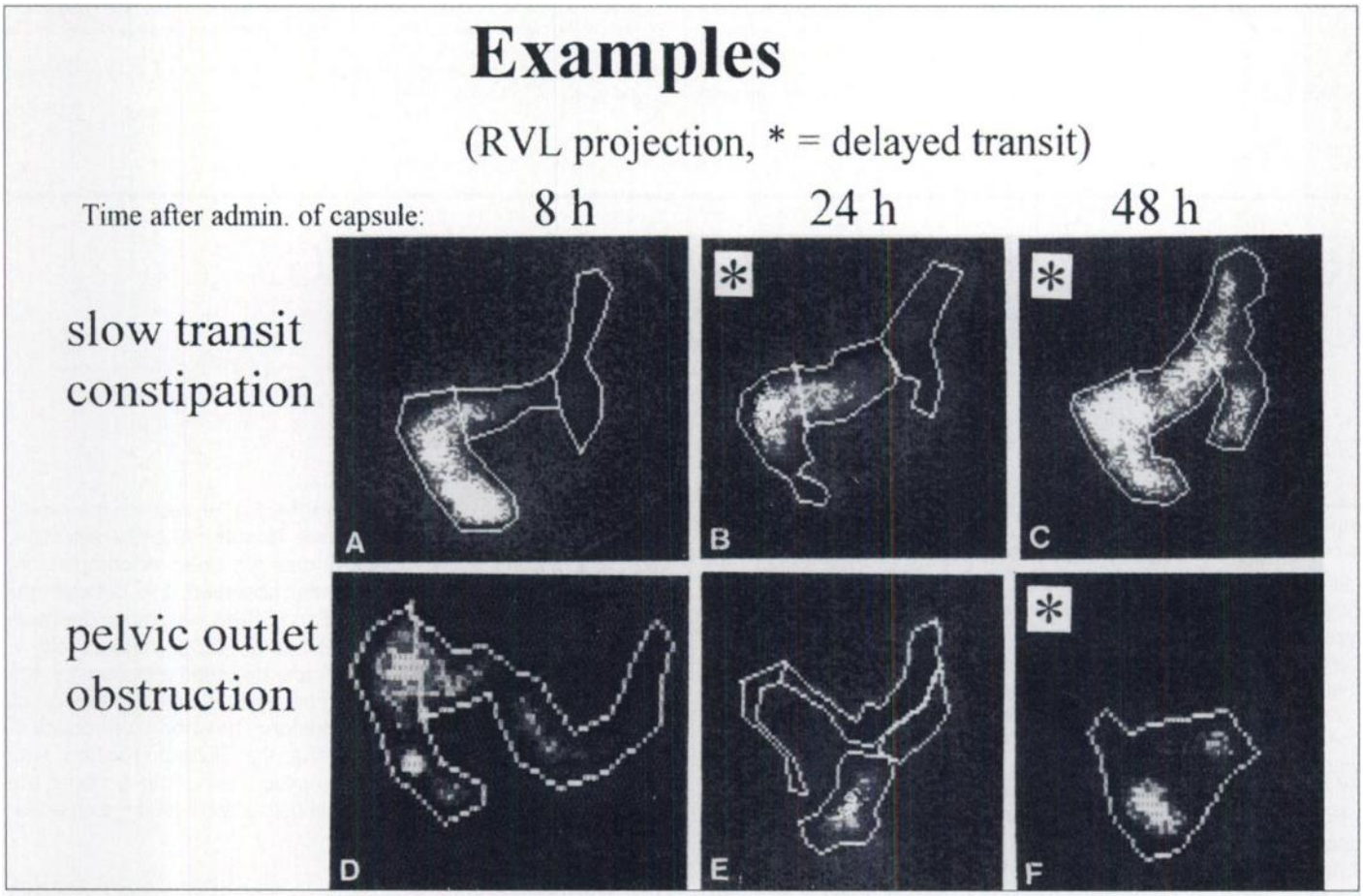

FIGURE 2. (A–C) Example of a female patient having slow transit constipation (Patient 19, 31-yr-old) ventral projections at 8, 24 and 48 hr. Twenty-four hours after oral administration of activity, most activity still remains in the cecum. After 48 hr, most of activity has only reached the right colonic flexure. (D–F) Example of a female patient having pelvic outlet obstruction (Patient 15, 21-yr-old) ventral projections at 8, 24 and 48 hr. Patient with normal transit velocity up to the rectum. Activity persists in the rectum until 48 hr after oral administration of the capsule. *Indicates a delayed transit. RVL = right-ventral-left view.

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REFERENCES

1. Aggarwal AM, Camilleri M, Phillips SF, Schlagheck TG, Brown ML, Thomforde GM. Olestra, a nondigestible, nonabsorbable fat. Effects on gastrointestinal and colonic transit. *Dig Dis Sci* 1993;38:1009–1014.
2. Camilleri M, Zinsmeister AR. Towards a relatively inexpensive, noninvasive, accurate test for colonic motility disorders. *Gastroenterology* 1992;103:36–42.
3. Hammer J, Camilleri M, Phillips SF, Aggarwal A, Haddad AM. Does the ileocolonic junction differentiate between solids and liquids? *Gut* 1993;34:222–226.
4. Stivland T, Camilleri M, Vassallo M, et al. Scintigraphic measurement of regional gut transit in idiopathic constipation. *Gastroenterology* 1991;101:107–115.
5. Vassallo M, Camilleri M, Phillips SF, Brown ML, Chapman NJ, Thomforde GM. Transit through the proximal colon influences stool weight in the irritable bowel syndrome. *Gastroenterology* 1992;102:102–108.
6. von der Ohe MR, Camilleri M. Measurements of small bowel and colonic transit: indications and methods. *Mayo Clin Proc* 1992;67:1169–1179.
7. Krevsky B, Maurer AH, Fisher RS. Patterns of colonic transit in chronic idiopathic constipation. *Am J Gastroenterol* 1989;84:127–132.
8. Barrow L, Steed KP, Spiller RC, et al. Scintigraphic demonstration of lactulose-induced accelerated proximal colon transit. *Gastroenterology* 1992;103:1167–1173.
9. Krevsky B, Maurer AH, Malmud LS, Fisher RS. Cisapride accelerates colonic transit in constipated patients with colonic inertia. *Am J Gastroenterol* 1989;84:882–887.
10. Kaufman PN, Richter JE, Chilton HM, et al. Effects of liquid versus solid diet on colonic transit in humans. Evaluation by standard colonic transit scintigraphy. *Gastroenterology* 1990;98:73–81.
11. Krevsky B, Libster B, Maurer AH, Chase BJ, Fisher RS. Effects of morphine and naloxone on feline colonic transit. *Life Sci* 1989;44:873–879.
12. Krevsky B, Maurer AH, Niewiarowski T, Cohen S. Effect of verapamil on human intestinal transit. *Dig Dis Sci* 1992;37:919–924.
13. Kamm MA. The small intestine and colon: scintigraphic quantitation of motility in health and disease. *Eur J Nucl Med* 1992;19:902–912.
14. Wilding IR, Davis SS, Bakhshaee M, Stevens HN, Sparrow RA, Brennan J. Gastrointestinal transit and systemic absorption of captopril from a pulse-release formulation. *Pharm Res* 1992;9:654–657.
15. McLean RG, Smart RC, Lubowski DZ, King DW, Barbagallo S, Talley NA. Oral colon transit scintigraphy using indium-111 DTPA: variability in healthy subjects. *Int J Colorectal Dis* 1992;7:173–176.
16. Price JM, Davis SS, Wilding IR. Characterization of colonic transit of nondisintegrating tablets in healthy subjects. *Dig Dis Sci* 1993;38:1015–1021.
17. Steed KP, Bohemen EK, Lamont GM, Evans DF, Wilson CG, Spiller RC. Proximal colonic response and gastrointestinal transit after high and low fat meals. *Dig Dis Sci* 1993;38:1793–1800.
18. Healey JN. Gastrointestinal transit and release of mesalazine tablets in patients with inflammatory bowel disease. *Scand J Gastroenterol* 1990;172(suppl):47–51.
19. Reddy SN, Bazzocchi G, Chan S, et al. Colonic motility and transit in health and ulcerative colitis. *Gastroenterology* 1991;101:1289–1297.
20. Meyer-Wyss B. Dickdarmmotilität: Vom Colon irritabile bis zur Obstipation. *Ther Umsch* 1991;48:488–493.
21. Pelli MA, Bassotti G, Gattucci M, Scionti L, Santeusanio F, Morelli A. Hydrogen breath test and scintigraphic gastrocolic transit time in diabetics with autonomic neuropathy. *Recenti Prog Med* 1993;84:27–33.
22. Wegener M, Wedmann B, Langhoff T, Schaffstein J, Adamek R. Effect of hyperthyroidism on the transit of a caloric solid-liquid meal through the stomach, the small intestine, and the colon in man. *J Clin Endocrinol Metab* 1992;75:745–749.
23. Bazzocchi G, Ellis J, Villanueva-Meyer J, Reddy SN, Mena I, Snape WJ Jr. Effect of eating on colonic motility and transit in patients with functional diarrhea. Simultaneous scintigraphic and manometric evaluations. *Gastroenterology* 1991;101:1298–1306.
24. Picon L, Lemann M, Flourie B, Rambaud JC, Rain JD, Jian R. Right and left colonic transit after eating assessed by a dual isotopic technique in healthy humans. *Gastroenterology* 1992;103:80–85.
25. Roberts JP, Newell MS, Deeks JJ, Waldron DW, Garvie NW, Williams NS. Oral ^{111}In-DTPA scintigraphic assessment of colonic transit in constipated subjects. *Dig Dis Sci* 1993;38:1032–1039.
26. Vattimo A, Burroni L, Bertelli P, Messina M, Meucci D, Tota G. Total and segmental colon transit time in constipated children assessed by scintigraphy with ^{111}In-DTPA given orally. *J Nucl Biol Med* 1993;37:218–222.
27. Sciarretta G, Furno A, Mazzoni M, Ferrieri A, Malaguti P. Scintigraphic study of gastrointestinal transit and disintegration sites of mesalazine tablets labeled with technetium-99m. *Scand J Gastroenterol* 1993;28:783–785.
28. McLean RG, Smart RC, Gaston-Parry D, et al. Colon transit scintigraphy in health and constipation using oral iodine-131-cellulose. *J Nucl Med* 1990;31:985–989.
29. Smart RC, McLean RG, Gaston-Parry D, et al. Comparison of oral iodine-131-cellulose and indium-111-DTPA as tracers for colon transit scintigraphy: analysis by colon activity profiles. *J Nucl Med* 1991;32:1668–1674.
30. Stubbs JB, Valenzuela GA, Stubbs CC, et al. A noninvasive scintigraphic assessment of the colonic transit of nondigestible solids in man. *J Nucl Med* 1991;32:1375–1381.
31. Kamath PS, Phillips SF, O'Connor MK, Brown ML, Zinsmeister AR. Colonic capacitance and transit in man: modulation by luminal contents and drugs. *Gut* 1990;31:443–449.
32. International Commission on Radiological Protection. *Radiation dose to the patient from radiopharmaceuticals*, ICRP Publication 53. *Oxford: Pergamon Press; 1988.*
33. Drexler G, Wiedemann L, Panzer W. *Die Bestimmung von Organdosen in der Röntgendiagnostik*, 2nd ed. Berlin: Hoffmann; 1993.
34. Schindlbeck NE, Klauser AG, Müller-Lissner SA. Messung der Kolontransitzeit. *Z Gastroenterol* 1990;28:399–404.

Reproducibility of Technetium-99m-MAG3 Clearance Using the Bubeck Method

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The objective of this study was to estimate the reproducibility of ^{99m}Tc-mercaptoacetyltriglycine (^{99m}Tc-MAG3) clearance calculated using a single-sample method. **Methods:** One hundred forty-seven patients with urological or ear, nose and throat cancer were analyzed in a retrospective study. Each patient had at least two clearance studies with ^{99m}Tc-MAG3 before chemotherapy treatments to monitor renal function. Up to five clearance studies per patient were considered. The reproducibility was estimated by comparing two consecutive investigations. Pairs of investigations with a change in split renal function of more than 5% or an interval of more than 50 days were excluded. Clearance was determined using the Bubeck method. For each pair of consecutive clearance data, the difference between the first and the second measurements was expressed as a percentage of the mean value of the two measurements. The mean of these normalized differences represents the systematic deviation, and the s.d. represents the reproducibility of the compared clearances. **Results:** After the selection, 242 pairs of consecutive clearance data remained for comparison. Significantly different clearances were observed only between investigations 0 and 1 and between 4 and 5. The systematic deviation of these comparisons totaled −3.8% and −5.7%, respectively. In the other comparisons, no significant deviation induced by the chemotherapy was found. The reproducibility calculated for all comparisons totaled 11.7%. **Conclusion:** The error of reproducibility of ^{99m}Tc-MAG3 clearance using the Bubeck method was ≤11.7%. This was an acceptable value, taking into account the greater fluctuation of tubular function compared with the glomerular filtration rate.

Key Words: clearance studies; technetium-99m-MAG3; Bubeck method

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