

peer reviewed ORIGINAL ARTICLE

# Does the everyday lifestyle diet of patients for screening CT colonography impact on their bowel cleaning and perceptions of a one-day liquid diet?

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## Abstract

**Aim:** To ascertain whether patients' everyday diets for at least the past six months impact on bowel cleansing and their perceptions of the bowel preparation at screening CT colonography (CTC) and the taste of iohexol.

**Methodology:** A questionnaire was used in this prospective quantitative study. Consecutive patients who presented for screening CTC over a five week period voluntarily completed the questionnaire. A separate assessment was used to rate bowel preparation: poorly prepared bowel with lots of residual stool was graded as 1; good bowel preparation with some residual stool was graded as 2; excellent bowel preparation with no residual stool was graded as 3.

**Results:** Fifty-six patients (n=56) completed the questionnaire. Only two patients followed an everyday diet of mainly red meat over the past six months. Forty-seven (84%) followed a mainly white meat/fish diet; seven (12%) followed a vegetarian diet without meat or fish. The majority (89%) presented with excellent bowel preparation with no residual stool. Four patients (a vegetarian and three on mainly a white meat/fish diet) experienced being very hungry. Five (9%) reported feeling nauseous; the majority stated the taste of iohexol was not a problem (48%) or was slightly unpleasant (n=20/36%).

**Conclusion:** Four patients (7%) were assessed as having good bowel preparation; fifty (89%) had excellent bowel preparation with no residual stool and minimal or no residual fluid. The majority (84%) followed a mainly white meat/fish diet. Future studies that have a bigger sample may provide different results. Studies could also be done to compare bowel preparation of patients who predominantly follow a red meat diet versus those that follow a total white meat/fish diet.

**Keywords** red meat, white meat, fish, vegetarian, cramping, bloating, hunger pangs

## INTRODUCTION

Worldwide colorectal cancer (CRC) is the second most common cancer in women and the third most in men.<sup>[1]</sup> Literature states that by 2030 the global burden of CRC is expected to increase by 60% new cases thus it is important to reduce this predicted burden.<sup>[2]</sup> Currently there are several tests to screen for CRC including optical colonography (OC) and computed tomographic colonography (CTC).<sup>[3]</sup> The latter two are sensitive screening tools; they do however require fairly aggressive bowel cleansing which many patients see as a barrier. It is thus not surprising that studies continue to be undertaken to find the best bowel cleansing method that would be accepted by CTC patients.<sup>[4-8]</sup> Studies have been done to assess one, two or three-day preparation; non-cathartic unrestricted diet; limited bowel preparation; liquid diet; low-fibre diet; cathartic bowel preparation together with tagging agents; wet bowel preparation, for example.<sup>[9-12]</sup>

For a successful study it is important that a clean bowel is well distended, and that residual fluid is tagged.<sup>[13,14]</sup> Figures

1a to d show poor and very good bowel cleansing. A dry bowel preparation is routine. The protocol is: (i) at 11:00 2 x 5mg bisacodyl (Dulcolax) tablets are ingested with one glass (8 ounces/234mL) clear fluid, (ii) 296 mL solution of magnesium citrate ingested at 14:00 and a further 296 mL at 17:00 on the day before the study, (iii) tagging agent 250 mL of 2.1% w/v Readi-Cat® is ingested at 17:00 (it stains any remaining stool), and (iv) at 20:00 50 cc iohexol (Omnipaque) is ingested to stain any residual fluid white.<sup>[13]</sup> Patients are required to adhere to a one-day clear liquid diet to aid bowel catharsis as well as to ensure hydration because of osmotic fluid loss.<sup>[8]</sup>

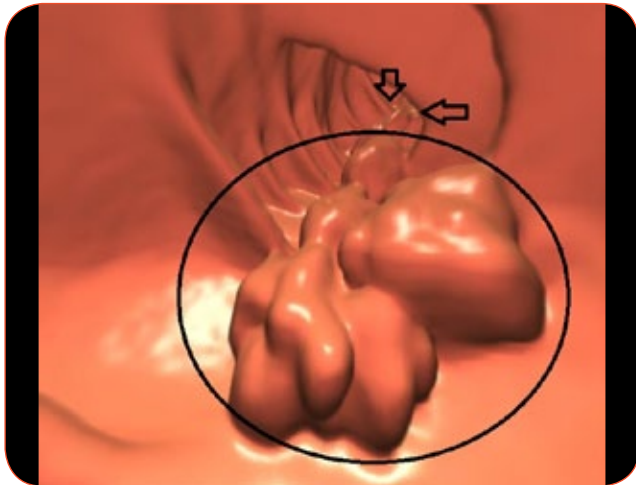
Literature is silent on whether everyday diets of patients have an impact on bowel cleansing. This study therefore focused on everyday diets of asymptomatic patients, from a similar socioeconomic background, who underwent screening CTC that involved cathartic bowel preparation, tagging agents, and a one-day liquid diet.<sup>[14]</sup> To the best of the main author's knowledge there have not been studies done of the possible impact of everyday lifestyle

diets in terms of bowel cleansing and patients' perceptions of CTC. This study aimed to ascertain whether such diets had an impact on bowel cleansing and patients' perceptions of the bowel preparation. There were three broad objectives that underpinned the study.

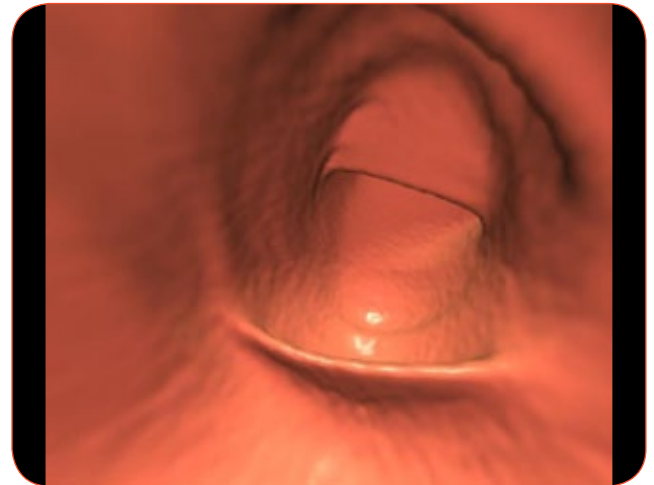
1. To compare the CTC images of patients, with different everyday lifestyle diets over at least the past six months, in terms of optimal colon cleansing.
2. To determine which patients experienced hunger pangs, if any, in terms of their everyday lifestyle diet.
3. To determine whether a lifestyle diet has an effect on patients' feedback on taste of the tagging agent iohexol.

## METHODS AND MATERIALS

To address the aims and objectives of this prospective study a questionnaire was compiled to obtain quantitative feedback from patients. Consecutive patients who presented for screening CTC during a five week period were asked to complete a questionnaire. The nine-closed ended questions covered: everyday diets over the



**Figure 1a.** 3D view showing excessive stool (black circle and arrows) in the colon.



**Figure 1b.** 3D view of descending colon showing good cleansing.



**Figure 1c.** 2D axial view of poorly cleansed bowel.



**Figure 1d.** 2D coronal view of poorly cleansed bowel. White circles show stool. White arrows indicate residual iohexol.

past six months, cramping, bloating, taste of the tagging agents, whether the liquid diet led to being hungry, whether they cheated and snacked before the study, and whether they had been anxious about the bowel preparation (Table 1). Their names, age and gender were already recorded on their CTC request forms. The patients were informed completion of the questions was voluntary and that their personal data would not be divulged. They were assured of their rights to confidentiality and anonymity in accordance with the principles of research ethics. The questionnaire was piloted to check that the questions addressed the aim and objectives of the study. Three patients completed the research tool and minor changes were made to the wording of two questions. Piloting addressed the validity and reliability of the tool.<sup>[15]</sup> The data of the piloted questionnaire were not included in the study.

Microsoft EXCEL software was used to capture and calculate the responses. Non-probability convenience sampling was used. The inclusion criterion was patients who presented for screening CTC examination over a five week period and who could complete the questionnaire. A stroke patient could not write and was excluded from the study. Bowel cleansing was evaluated by using grading 1 to 3 where 1 = poorly prepared with lots of residual stool; 2 = good preparation with some residual stool present; 3 = excellent preparation with no residual stool and minimal fluid remaining. Grading was done by the radiographers (radiologic technologists) who did the CTCs, and thereafter by the main author when viewing the images. This was done to reduce subjectivity in assessment of bowel preparation.

## RESULTS

Fifty-six (n=56) patients who met the in-

clusion criterion voluntarily completed the questionnaire. There were nine males and 47 females. The majority (n=51) were older than 50 years. Twenty-seven (n=27) had never had a screening or diagnostic CTC. The everyday diets of all the patients are presented in Table 2. Table 3 shows the results of bowel preparation in terms of poorly prepared (1), good preparation (2), and excellent preparation (3). Table 4 presents the patients' feedback on hunger pangs. Tables 5 to 7 present the results of patients' feedback on cramping, taste of iohexol, and bloating.

All stated that they had not cheated by eating snacks during their liquid diet or on the morning of their CTC study. Twenty-seven (48%) had never had a previous CTC. Three patients, all over 70 years old, stated they would not have another CTC. The overwhelming majority (n=53/95%) responded in the affirmative in

**Table 1.** Assessment of patient experience of CTC bowel preparation

| # | QUESTION   | OPTIONS                     |                        |                           |                  |                           |
|---|--|-----------------------------|------------------------|---------------------------|------------------|---------------------------|
| 1 | What has been your normal diet for the past 6 months or longer?  | Mainly red meat             | Mainly white meat/fish | Vegetarian                | Vegan            |                           |
| 2 | Select your experience of the bowel preparation yesterday and today  | No cramps                   | Mild cramps            | Moderate frequent cramps  | Severe cramps    | Excessive frequent cramps |
| 3 | Select your experience of the taste of the bowel preparation.  | No problem with the taste   | Taste was not pleasant | Taste was very unpleasant | Made me nauseous |                           |
| 4 | Select your experience of the 24 hour liquid diet in terms of bloating yesterday and this morning                    | Did not experience bloating |                        | Experienced some bloating |                  |                           |
| 5 | Select your experience of hunger pangs yesterday and this morning  | Did not feel hungry         | Felt slightly hungry   | Felt very hungry          |                  |                           |
| 6 | Did you cheat and eat some snacks or something similar yesterday or this morning before coming for your examination? | Yes                         |                        | No                        |                  |                           |
| 7 | Is this your first CTC?  | Yes                         |                        | No                        |                  |                           |
| 8 | Would you have another CTC based on your overall experience of the bowel preparation and the clear liquid diet?      | Yes                         |                        | No                        |                  |                           |
| 9 | Did you feel anxious about having to undergo the bowel preparation and the 24 hour liquid diet?                      | Yes                         |                        | No                        |                  |                           |

terms of undergoing future CTC studies based on their overall experience of the bowel preparation and liquid diet. Thirty-two (n=32/57%) stated that they had felt anxious about the bowel preparation and liquid diet.

## DISCUSSION

There is consensus in the literature that cathartic bowel preparation, and tagging agents are pivotal in CTC.<sup>[4,12,13,17]</sup> For a successful study it is important that a clean bowel is well distended, and that residual fluid is tagged.<sup>[8]</sup> In order to achieve this requires a change of diet to reduce solid stool in the colon; solid foods must not be consumed for at least 24 hours before the examination.<sup>[8]</sup> It is thus important that patients must be informed of their responsibilities before and during a CTC examination. It is essential that they adhere to a clear liquid diet and take the bowel preparation medication at the correct times.<sup>[14]</sup> Literature focuses on change of diet before a CTC,<sup>[9-12]</sup> but the everyday diet of patients has not been assessed in the literature in terms of overall bowel cleansing. This study focused on determining whether patients' everyday diets for at least the past six months impact on bowel cleansing, and their overall perceptions of the bowel preparation at screening CTC. The patients in the study were from a similar socioeconomic background. The majority (n= 47/84%) followed a white meat or fish

**Table 2.** Normal everyday diet for the past six months or longer (n=56)

| MAINLY RED MEAT | MAINLY WHITE MEAT/FISH | VEGETARIAN | VEGAN |
|-----------------|------------------------|------------|-------|
| 2               | 47                     | 7          | 0     |

**Table 3.** Assessment of bowel preparation (n=56)

| BOWEL PREPARATION ASSESSMENT   | NUMBER      | NEAREST %   |
|--|-------------|-------------|
| 1 = poorly prepared: lots of residual stool                              | 2           | 4%          |
| 2 =good preparation: some residual stool                                 | 4           | 7%          |
| 3 = excellent preparation: no residual stool and minimal fluid remaining | 50          | 89%         |
| <b>Total</b>   | <b>n=56</b> | <b>100%</b> |

**Table 4.** Patients' feedback on hunger pangs (n=56)

| DID NOT FEEL HUNGRY | SLIGHT HUNGER PANGS | FELT VERY HUNGRY |
|---------------------|---------------------|------------------|
| 25                  | 27                  | 4                |

**Table 5.** Feedback on cramping (n=56)

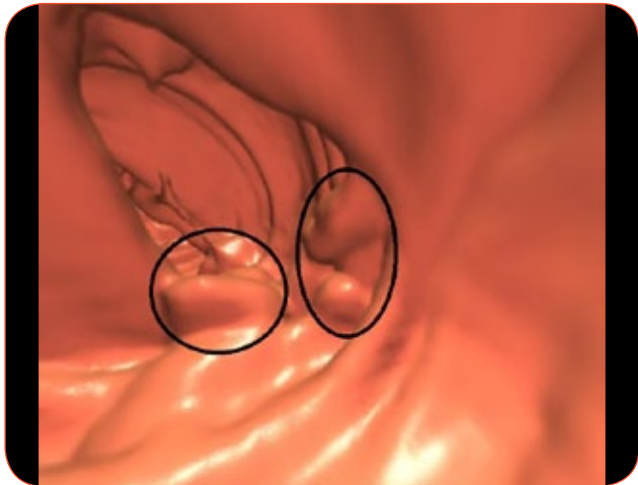
| NO CRAMPS | MILD CRAMPS | FREQUENT MODERATE CRAMPS | SEVERE CRAMPING | EXCESSIVE ON-GOING SEVERE CRAMPS |
|-----------|-------------|--------------------------|-----------------|----------------------------------|
| 17        | 31          | 3                        | 3               | 2                                |

**Table 6.** Feedback regarding taste of the tagging agent iohexol (n=56)

| NO PROBLEM WITH TASTE | TASTE NOT PLEASANT | TASTE VERY UNPLEASANT | MADE ME NAUSEOUS |
|-----------------------|--------------------|-----------------------|------------------|
| 27                    | 20                 | 4                     | 5                |

**Table 7.** Bloating feedback (n=56)

| NO BLOATING EXPERIENCED | SOME BLOATING EXPERIENCED |
|-------------------------|---------------------------|
| 35                      | 21                        |



**Figure 2.** 3D view showing poorly prepared bowel with lots of stool (black circles).

diet. Seven patients followed a vegetarian diet that excluded meat and fish as shown in Table 2. In order to assess whether everyday diet impacts on bowel preparation the 3D and 2D CTC images of each patient were carefully scrutinised and assessed and allocated a grading of 1,2, or 3 as presented in Table 3. Colon cleansing was graded as 3 (excellent preparation) in the two patients whose everyday diet comprised red meat.

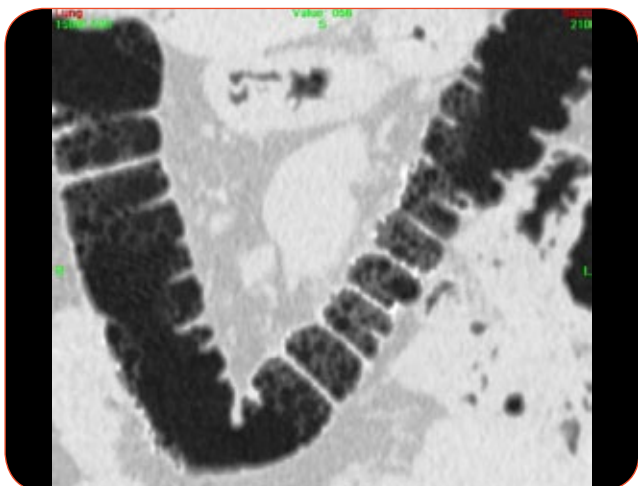
Two patients, with mainly white meat and fish diets, were poorly prepared and were graded as 1. Figure 2 is a 3D view of one of these patients. One patient failed to follow instructions and omitted taking the Dulcolax (bisacodyl) tablets and also had an insufficient fluid intake. One of the four patients with good preparation (graded 2), namely, minimal residual stool with some residual fluid, suffered from constipation and should, in hindsight, have been given three bottles of magnesium citrate. The other patient did not have excessive stool, but



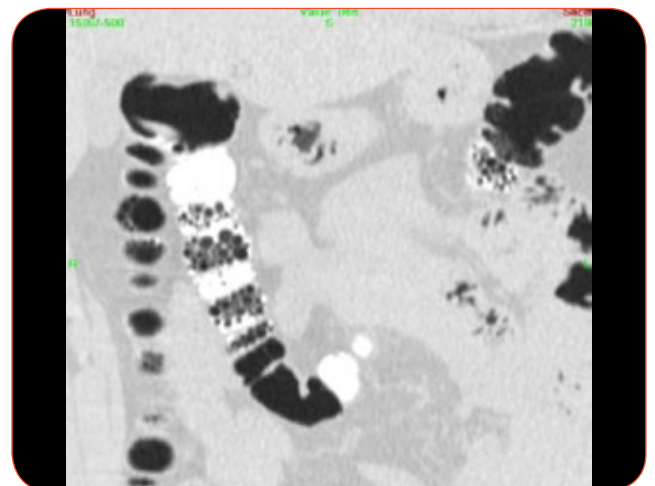
**Figure 3a.** 2D axial view shows non-frothy iodine tagging residual fluid.



**Figure 3b.** 2D axial with lung settings shows the frothy appearance of iodine (open white arrows).



**Figure 3c.** 2D view showing frothy iodine.



**Figure 3d.** 2D with lung settings clearly showing the frothy iodine.

there was a frothy appearance of iohexol (Figures 3a to d). This patient's liquid intake was only coffee. It is not possible to link frothy iohexol to this patient's consumption of only coffee. Literature reports on frothy appearance of iohexol in some patients; the reasons for this appearance are not known.<sup>[16,17]</sup> Figures 4a to d show excellent bowel preparation in one of the 50 patients with a grading of 3.

The results to determine whether patients experienced hunger pangs in terms of their lifestyle diet showed that only four out of the fifty-six patients indicated that they were very hungry as shown in Table 4. Of note is that all patients in this study did not snack before their CTC examina-

tions. If they had done so this would have resulted in excessive stool in the colon due to consumption of solid food. Figures 5a and b show excessive stool in the bowel of a patient of a few years ago who did snack before his CTC study. His CTC examination was rescheduled.

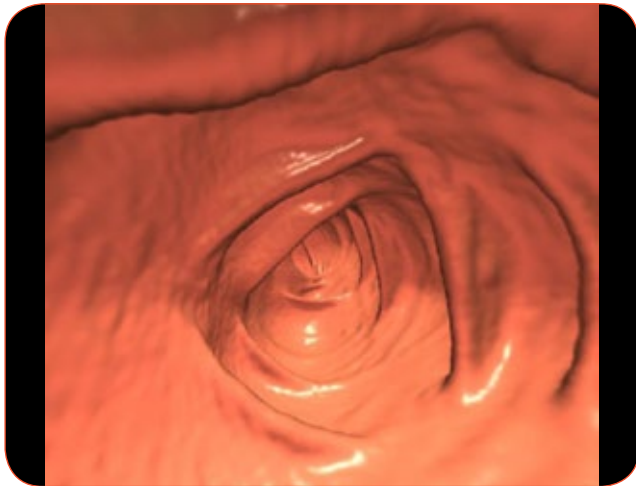
Studies have been done to compare non-ionic iohexol and ionic diatrizoate as tagging agents in CTC as part of a cathartic bowel regime.<sup>[16]</sup> Literature reports that iohexol is more palatable for patients<sup>[18,19]</sup> and that diatrizoate has an unpleasant taste.<sup>[4]</sup> One objective in this study was to determine whether a lifestyle diet has an effect on patients' feedback on taste of the tagging agent iohexol. The results,

as presented in Table 6, showed that five patients reported feeling nauseous. However, we need to bear in mind that patients do not have the exact same sense of taste. It was thus not possible to accurately determine patients' responses to the tagging agent.

## LIMITATIONS

This study was limited to upper middle class patients who mainly followed a white meat/fish diet. Fifty-six patients completed the questionnaire. This was a small non-probability sample thus one cannot generalise the findings.

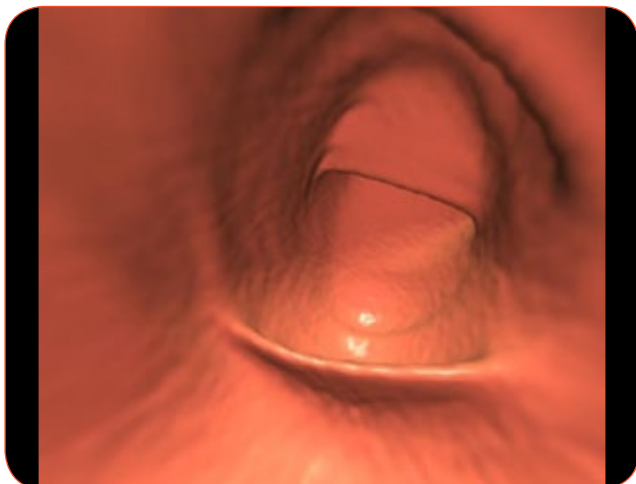
Another limitation was that it was assumed the use of 'mainly' for everyday



**Figure 4a.** 3D view of caecum and ascending colon showing excellent bowel cleansing.



**Figure 4b.** 2D axial view of the caecum and ascending colon showing excellent bowel cleansing as there is no evidence of stool. Minimal residual fluid present (open black arrows).



**Figure 4c.** 3D view of descending colon showing excellent bowel cleansing.



**Figure 4d.** 2D coronal view showing excellent bowel cleansing as there is no evidence of stool. No residual iohexol visualised.

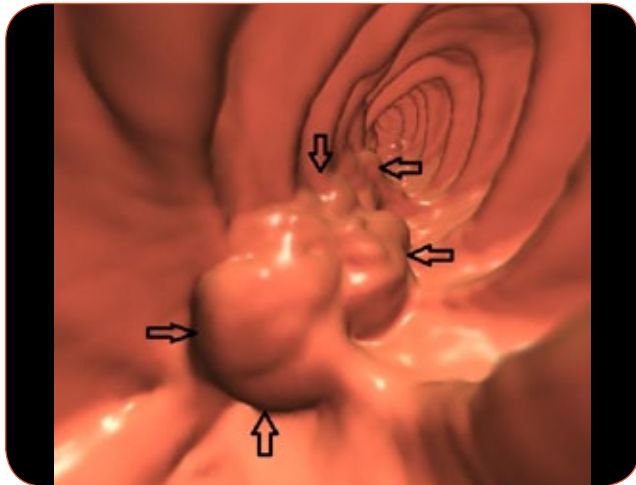


Figure 5a. 3D view showing stool (arrows).

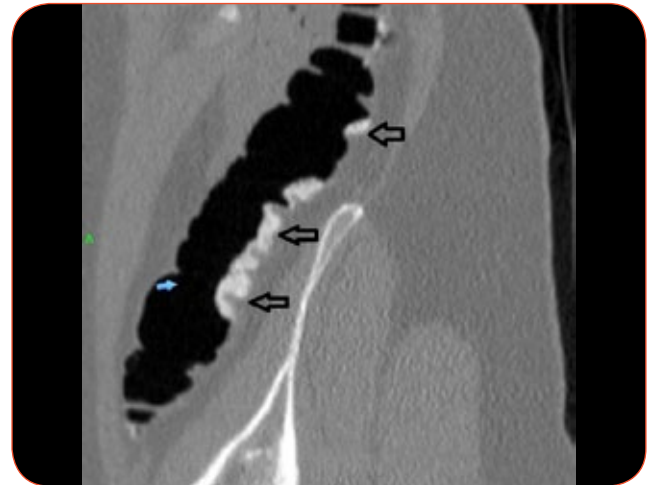


Figure 5b. 2D view showing stool (arrows).

diets would be understood by the patients to mean predominantly. Perhaps there should have been a question to include a mixed red/white meat diet.

## CONCLUSION

CTC literature reports on various bowel preparation regimes and the use of tagging agents.<sup>[6-10,20,21]</sup> However, literature is silent in terms of everyday diet and quality of bowel cleansing. This study assessed bowel preparation of 56 patients to determine whether their everyday diets, for at least the past six months, impacted on the quality of their bowel preparation. The aim, and three broad objectives of the study, were addressed in the questionnaire, and the assessment of bowel preparation. Bowel preparation was rated 1 to 3: poorly prepared with excessive residual stool; good preparation with some residual stool; and excellent preparation with

no residual stool and minimal fluid remaining. Four patients (7%) were assessed as having good bowel preparation, and fifty (89%) had excellent bowel preparation. The majority (84%) followed a white meat/fish diet.

Four indicated they had felt very hungry because the bowel preparation excludes solid food for at least 24 hours before a CTC examination. Feeling hungry is a subjective response to hunger pangs. Most patients did not find the taste of iohexol unpleasant; five indicated it made them nauseous.

In terms of cramping, two (3%) reported that they had experienced excessive cramping; three (5%) had severe cramping. The majority (62%) did not experience bloating. The vast majority (95%) responded in the affirmative in terms of undergoing future CTC studies based on

their overall experience of the dry bowel preparation, dual-tagging agents, and liquid diet.

It is suggested that future studies should be done to compare a mainly red meat diet versus mainly white meat/fish in terms of bowel preparation of screening CTC patients who followed the same routine dry preparation and dual-tagging regime reported in this study. It is recommended that the research tool in Table 1 should be used.

## CONFLICT OF INTEREST

None to declare

## CONTRIBUTIONS OF THE AUTHORS

JHB collected the data. LM captured the data. They both contributed to writing this paper.

## REFERENCES

1. World Health Organisation. International Agency for Research on Cancer. [cited 2018 July 16]. Available from: [http://globocon.iarc.fr/Pages/factsheets\\_cancer.aspx?cancer=colorectal](http://globocon.iarc.fr/Pages/factsheets_cancer.aspx?cancer=colorectal)
2. Arnold M, Sierra MS, Laversanne M, Soerjomataram I, Jemal A, Bray F. Global patterns and trends in colorectal cancer incidence and mortality. *GUT* 2017; 66(4):683-691.
3. Agha M, Mansy H, Ellatif HA. Virtual colonoscopy: technical guide to avoid traps and pitfalls. *The Egyptian Journal of Radiology and Nuclear Medicine*, 2016; 47:17-31.
4. Yee J, Weinstein S, Morgan T, Alore P, Aslam R. Advances in CT colonography for colorectal screening and diagnosis. *J of Cancer* 2013; 4 (3):200-209.
5. Pickhardt PJ. CT colonography: does it satisfy the necessary criteria for a colorectal screening test? *Expert Dev Gastroenterol* 2014; 8 (3): 211-213.
6. Jensch S, de Vries AH, Peringa J, Bipat S et al. CT colonography with limited bowel preparation: performance characteristics in an increased risk population. *Radiology* 2008; 247:122-132.
7. Sali L, Ventura L, Borgheresi A, Delsanto S et al. Patient experience of screening CT colonography with reduced and full bowel preparation in a randomised trial. Presented at ECR 2018, Vienna 28 February to 4 March 2018.
8. Chang J, Kim DH. CTC technique: methods to ensure an optimal exam. *Abdom Radiol* 2018; 43:523-538.
9. Pickhardt PJ. Colonic preparation for computed tomographic colonography: understanding the relative advantages and disadvantages of a noncathartic approach. *Mayo Clin Proc* 2007; 82 (6):659-661.
10. Johnson CD, Manduca A, Fletcher JG, MacCarty RL, et al. Noncathartic CT colonography with stool tagging: performance with and without electronic stool subtraction. *AJR* 2008; 190:361-366.
11. Liedenbaum MH, Denters MJ, de Vries AH, van Ravesteijn VF et al. Low-fiber diet in limited bowel preparation for CT colonography: influence on image quality and patient acceptance. *AJR* 2010; 195:W31-W37.
12. Pickhardt PJ. Screening CT colonography: how I do it. *AJR* 2007; 189 (2):290-298.
13. Bortz JH. CT colonography: an approach for a successful examination. *S Afr J Rad*

- 2014; 18 (1); Art. #607, 11 pages. <http://dx.doi.org/10.4102/sajr.v18i1.607> SAJR 2014.
14. Bortz JH. Patient preparation including bowel preparation, the role of tagging and methods of colonic insufflation. In Bortz et al (Eds) CT colonography for radiographers. A guide to performance and image interpretation 2016:91-101. DOI. 10.1007/978-3-319-29379-0\_9
  15. Maree JG (Ed). First steps in research. Pretoria: Van Schaik, 2016.
  16. Johnson B, Hindshaw JL, Robbins JB, Pickhardt PJ. Objective and subjective intrapatient comparison of iohexol versus diatrizoate for bowel preparation at CT colonography. AJR 2016; 206 (2):1202-1207.
  17. Kim B, Park SH, Hong GS, et al. Iohexol versus diatrizoate for fecal/fluid tagging during CT colonography performed with cathartic preparation: comparison of examination quality. Eur Radiol. 2015.
  18. McNamara MM, Lockhart ME, Fineberg NS, Berland LL. Oral contrast media for body CT: comparison of diatrizoate sodium and iohexol for patient acceptance and bowel opacification. AJR 2010; 195:1137-1141.
  19. Pollentine A, Ngan-Soo E, McCoubrie P. Acceptability of oral iodinated contrast media: a head-to-head comparison of four media. British Journal of Radiology. 2013; 86.
  20. Liedenbaum MH, de Vries AH, Gouw C, van Rijn AF et al. CT colonography with minimal bowel preparation: evaluation of tagging quality, patient acceptance and diagnostic accuracy in two iodine-based schemes. Eur Radiol 2010;20:367-376.
  21. Neri E, Lefere P, Gryspeerdt S, Bemis P, Mantarro A, Bartolozzi C. Bowel preparation for CT colonography. European Journal of Radiology 2013; 82: 1137-1143.