EVALUATION OF DIAGNOSTIC ACCURACY OF DYNAMIC MR DEFECOGRAPHY COMPARED WITH EVACUATION PROCTOGRAPHY AMONG PATIENTS WITH CONSTIPATION

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Background: Chronic constipation is very common, affecting 10.9% of Asian populations. The etiology of constipation is also very variable and can be classified as functional or structural. Structural constipation can be determined by physical examination and colonoscopy while those without structural causes can be further evaluated with physiologic tests. The current gold standard physiologic test for constipation is evacuation proctography. However, dynamic MR defecography has gained reputation as a useful tool in evaluating constipation as a less invasive test that avoids radiation exposure and provides better anatomical function and interaction of pelvic organs.

Objective: The aim of this study was to compare diagnostic accuracy of dynamic MR defecography (MR-D) with evacuation proctography (EP) to assess patients who present constipation.

Materials and Methods: From August 2012 to January 2013, 19 patients requiring EP to assess the cause of constipation were enrolled in this study. All patients were asked to undergo MR-D. The images from MR-D and EP were reviewed by a radiologist expert in gastrointestinal radiology. Features evaluated included the presence and degree of anterior rectocele, rectoanal intussusception, sigmoidocele, increased fixed perineal descent and increased dynamic perineal descent.

Results: No statistical difference was observed in terms of the prevalence of abnormalities detected by both EP and MR-D in this study. The sensitivity of MR-D in detecting rectoanal intussusception, anterior rectocele and increased dynamic perineal descent was 36.4%, 64.3% and 80%, while the specificity was 87.5%, 80% and 50%, respectively. The overall sensitivity and specificity of MR-D in detecting any abnormalities were 56.7% and 86.2%, respectively. Sigmoidocele and increased fixed perineal descent were not found among any patients enrolled in this study.

Conclusion: MR-D has lower sensitivity than EP in detecting anterior rectocele and much lower when detecting rectoanal intussusception. On the other hand, it has high sensitivity in finding increased dynamic perineal descent due to its intrinsic properties. Although less invasive than EP in terms of radiation exposure, our method of MR-D shows no better diagnostic accuracy than that of EP. MR-D may play a better role in evaluating the anterior portion of the pelvic organ, which cannot be examined by EP.

Keywords : Diagnostic accuracy, MR defecography, Evacuation proctography

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Introduction

Chronic constipation is a widespread problem and its prevalence has been estimated at 10.9% of Asian adult populations.[1] Although many causes of chronic constipation exist, they can usually be divided in two types, namely, primary (or functional) constipation in which no definite etiology or structural abnormality is observed and secondary (or structural) constipation as the name implies. In usual circumstances, a thorough history taking and physical examination are often enough to aid physicians in determining the roots of constipation, which can be due to a low fiber diet, inadequate water intake, lack of physical exercise, side effect of certain drugs and malignant bowel obstruction. When these secondary causes are ruled out, the remaining sources generally fall in the category of slow transit constipation, pelvic floor dysfunction or some combination of the two.[2] Physiologic testing can be used to identify and isolate the last two causes of constipation. Evacuation proctography (EP) is one type of physiologic test. EP is considered the gold standard method to evaluate the function of the sigmoid colon and rectum of patients, who have received a diagnosis of constipation particularly when symptoms do not improve after treatment with medication or behavior modification. The method in performing EP involves the use of fluoroscopy to capture the defecation process in which barium paste is substituted in place of real stool. EP can help to demonstrate various disorders of the rectum such as rectocele, sigmoidocele and rectoanal intussusception, which only emerge during the course of defecation.

Although EP is considered a standard procedure, any patient being tested will likely acquire a higher radiation dose than those receiving conventional X-ray due to the continuous radiation exposure from fluoroscopy. As described in the study by Goei et al.[3] EP produces a mean effective dose equivalent to 4.9 mSV ± 1.6 for women and 0.6 mSv ± 0.2 for men. While these values are unlikely to render any clinical symptoms, they are similar or higher than the legal limit for the public (up to 1 mSv per year).

Currently, through the constant evolution of MRI technology such as improvement of the strength of magnetic fields and better software performance to allow shorter scanning time, the MRI abdomen can now be performed while providing higher resolution and reducing image noise. Because of that, interest has increased in applying MRI in capturing the dynamic process of defecation. Since then, it has become a new technique, now called MR defecography (MR-D). Advantages of using MRI are evidently the lack of ionizing radiation, multi-planar imaging capability and better details of the anatomy in the pelvic region.

Several studies have been conducted attempting to compare the accuracy between EP and MR-D in detecting rectal abnormality. So far, the conclusion is that MR-D has lower overall accuracy than EP in detecting sigmoidocele and rectoanal intussusception. For example, Matsuoka et al.[4] noted that although MR-D costs more than ten times the EP, it did not result in any changes to the treatment of the patient.

However, as MR-D is a relatively new technique, it continuously evolves. For instance, Solopova et al.[5] who studied the subject of enema ingredients on MR-D, found that when the mixture of potato starch and gadopentetate dimeglumine is used instead of ultrasound jelly, it allows clearer detection of pelvic organ abnormality. Therefore, we were interested to see whether all the currently available MRI machines, software and proven MR-D techniques such as mixture rectal enema as described by Solopova et al. may help to increase the detection rate of rectal abnormality. That is, when MR-D accuracy is found to be better than or comparable to that of EP, it may be used freely as EP replacement. That would create benefits for patients in terms of reducing the radiation dose and for surgeons by providing them with the improved details of the anatomy of the pelvic organ.

Materials and Methods

Patients

This cross-sectional descriptive study was conducted between August 2012 and January 2013, and was approved by the institutional review board with written informed consent obtained from every patient.

Nineteen consecutive patients (5 men and 14 women; age range, 21 to 80 years; mean, 53.7±18.2 years) were recruited in this study. The inclusion criteria were clinically constipated patients, referred from other departments for EP exam. Upon arrival at the radiology department, performing MR-D on another occasion was offered. All patients included in this study agreed to undergo MR-D

after completing EP with an interval between one to four weeks but mostly on the day they came to receive the EP report.

The exclusion criteria included conditions prohibiting the subject from undergoing MRI exam (such as cardiac pacemaker, claustrophobia), allergy to gadopentetate dimeglumine and major surgery or treatment performed between the two imaging sessions.

Evacuation Proctography

For EP, bowel preparation was not needed before the study. In the examination room, patients were asked to lie on the left side and about 300 ml of standard contrast enema (a thick barium paste mixture comprising barium and potato starch) was injected in the patient's rectum by plastic syringe connected to the a catheter. The injection was stopped when the patient felt the sensation of rectal fullness. When the subject was female, the vagina was also coated with barium contrast. Once the patient preparation was completed, the fluoroscopic bed was rotated to the upright position. The patient was then seated on a radiolucent commode attached to the footboard of the bed, having the examination in the right lateral projection. When the fluoroscopic tube was in place, images were taken during (I) rest, (II) squeezing of anal sphincter, (III) straining without evacuation and (IV) evacuation. The entire investigation including patient preparation took approximately 15 to 20 minutes.

MR Defecography

All patients underwent MR-D in a closed magnet unit 1.5 Tesla (Achieva:Philips Medical Systems Nederland B.V., The Netherlands) in the supine position. Before the MRI session, the patient's rectum was filled with contrast enema, a mixture comprising 500 ml potato starch, 10 g and gadopentetate dimeglumine 2 ml. The injection was stopped once the subject felt a stimulus to evacuate. The localizer images were captured to obtain a preliminary survey of the pelvic region in three planes (axial T1W, coronal T2FS and sagittal T2FS). Based on the previous localizer images, a spoiled gradient echo sequence was performed in the midsagittal plane of the anal canal. The imaging parameters for this sequence as described below. TR 10 TE, 4.6 milliseconds, slice thickness, 3 ml, no gap and image matrix size 188 x 115. The images were obtained using this sequence (in similar manner as that of EP) during (I) rest, (II) squeezing of anal sphincter, (III) straining without evacuation and (IV) evacuation. The total acquisition time of all images plus the patient preparation was about 20 to 30 minutes.

Image Analysis

Both MR-D and EP images were analyzed by a radiologist, expert in gastro-intestinal radiology. Imaging analysis of both studies was performed at a workstation while the reader did not know which images belonged to which patients. The reader was asked to analyze all images regarding rectal abnormalities including anterior rectocele, rectoanal intussusception, sigmoidocele, increased fixed perineal descent (IFPD) and increased dynamic perineal descent (IDPD).

In this study, the anorectal angle (ARA) was derived by drawing a line parallel to the posterior edge of the rectum and another line along the longitudinal axis of the anal canal. The point where these two lines intersected indicated the location of the ARA.[6] (**Fig. 1**).

A pubococcygeal line (PC line) is defined as a line joining the inferior border of the pubic symphysis and the tip of the coccyx. When the pubic symphysis was not clearly seen, the lower border of the femoral neck would be used instead. The size of the perineal descent (PD) is equal to the distance of a line drawing from the location of the ARA perpendicular to the PC line (**Fig. 1**). When the PD is larger than 4 cm at rest, increased fix perineal descent (IFPD) is reported. Increased dynamic perineal descent (IDPD) is diagnosed during the maximal push effort only when the PD exceeds the values of 3 cm from those measured at rest .[7]

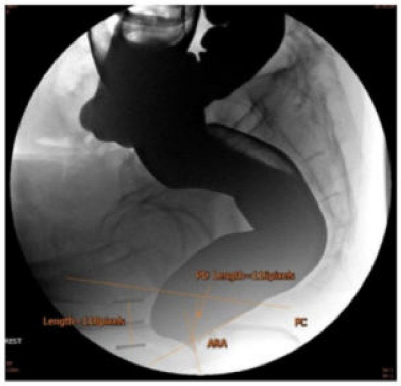

Fig. 1 EP image taken at rest; ARA = anorectal junction, PC = pubococcygeal line , PD = perineal descent

The anterior rectocele (ARC) was diagnosed and measured using the method described by Delemarre, et al.[8] as follows: First, a PC line was drawn as a baseline (using the previously described procedure). The distance between the projection of the anorectal angle (ARA') and the anterior rectal wall (ARC') on the baseline was used as the quantitative size of the ARC. When the distance between the ARA' and ARC' was more than 2 cm, anterior rectocele would be diagnosed **(Fig. 2 and 3)**

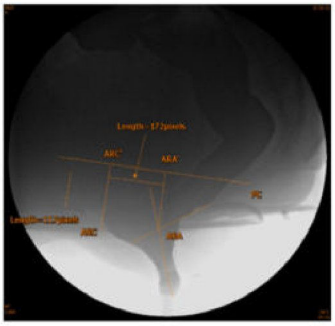

Fig. 2 EP image during maximal straining. ARC' = projection of anterior border of rectum on baseline. ARA' = projection of ARA on baseline. Distance between the two is the size of anterior rectocele.

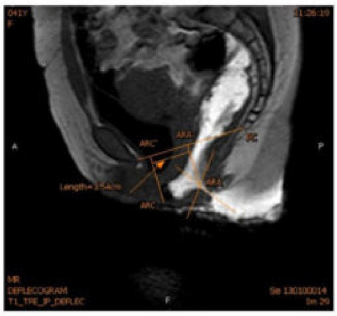

Fig. 3 MRD image taken during maximal straining, showing the same method of quantitative assessment of ARC.

The sigmoidocele is defined as the descent of the sigmoid colon either below the PC line or in the potential space between the vaginal canal and rectum. The diagnosis of rectoanal intussusception was made when the infolding of the rectum in anal canal is observed **(Fig. 4)**.

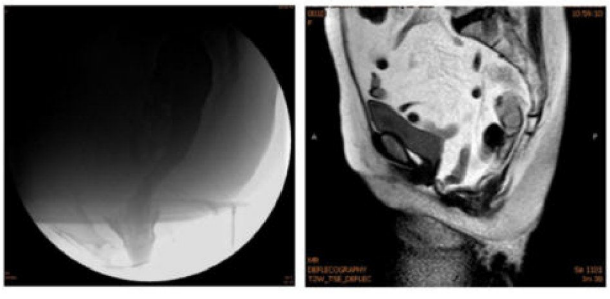

Fig 4. Rectoanal intussusception at EP (A) and at MR-D (B)

Statistical Analysis

Statistical analysis was performed using commercially available software (SPSS). The data were analyzed using descriptive statistics such as the mean, standard deviation and maximum and minimum values. Evaluation of diagnostic accuracy of MR-D was performed by measuring its sensitivity and specificity against EP, considered the gold standard test. The Chi-square test was used to compare the percentage prevalence of abnormalities found in the MR-D and EP. For all tests, a p -value of 0.05 or less was considered a statistically significant difference.

Results

Between August 2012 and January 2013, patients who required EP due to chronic constipation were asked to undergo MR-D. Nineteen participants were enrolled in this study, 14 were female with age ranging from 21 to 80 years; mean age was 53.7±18.2years.

The EP studies demonstrated anterior rectocele in 14 cases (3.7%). This group also showed other associated abnormalities. Only five patients showed anterior rectocele alone. Rectoanal intussusception was found among 11 cases (57.9%). In this group, only four patients did not present any other associated abnormality. Increased dynamic perineal descent was found among five cases (26.3%). All of these showed other associated abnormalities. One case at EP showed no detected abnormality .

The MR-D studies demonstrated 10 cases of anterior rectocele (52.6%), 5 cases of rectoanal intussusception (26.3%) and 11 cases of increased dynamic perineal descent (57.9%). No detectable sigmoidocele or increased fixed perineal descent was observed by these two methods.

Table 1. summarizes the comparable prevalence of all abnormalities detected by both EP and MR-D. Even though EP could demonstrate more cases of rectoanal intussusception and MR-D could demonstrate greater increased dynamic perineal descent, no significant difference was found between these two methods. The sensitivity, specificity, PPV and NPV of MR-D versus EP are reported in **Table 2**. The sensitivity in detecting rectoanal intussusception was low (36.4%). A fair sensitivity in detecting anterior rectocele (64.3%) and good sensitivity detecting increased dynamic perineal descent was observed (80%). The specificity for detecting anterior rectocele and rectoanal intussusception

was high (80% and 87.5%, respectively). Specificity in detecting increased dynamic perineal descent was fair (50%). The overall sensitivity and specificity of all abnormalities detected by MR-D were 56.7% and 86.2%, respectively.

Table 1. Comparable prevalence of the abnormalities detected by MR-D and EP

Abnormalities	EP	MR-D	P-Value (< 0.05)
Anterior rectocele	14 (73.7%)	10 (52.6%)	0.313
Rectoanal intussusception	11 (57.9%)	5 (26.3%)	0.099
Sigmoidocele	0	0	-
Increased fixed perineal descent	0	0	-
Increased dynamic perineal descent	5 (26.3%)	11 (57.9%)	0.099
Total	30	26	

Table 2. The sensitivity, specificity, PPV and NPV of MR-D compare with EP

Abnomalities	Sensitivity(%)	Specificity(%)	PPV(%)	NPV(%)
Anterior rectocele	64.3(9/14)	80 (4/5)	90 (9/10)	44 (4/9)
Rectoanal intussusception	36.4 (4/11)	87.5(7/8)	80 (4/5)	50 (7/14)
Sigmoidocele	-	-		
Increased fixed perineal descent	-	-		
Increased dynamic perineal descent	80 (4/5)	50 (7/14)	36.4(4/11)	87.5 (7/8)
Overall	56	86.2	65.4	81.2

Discussion

Almost all patients (except one case) presenting clinical symptom of chronic constipation, who were unable to identify the cause from history taking and physical examination, had underlying abnormalities such as anterior rectocele, rectoanal intussusception and abnormal perineal descent which could be detected by EP. Frequently coexisting abnormalities were found resembling those of the study of Cappabianca et al.[10] Their study presumed the coexisting abnormalities were caused by a weakening of multiple parts of the pelvic floor muscles. This indicated the need of a multidisciplinary team including a colorectal surgeon, gynecologist and urologist as well as a radiologist, who provided panoramic radiographic viewpoints and clear details of the abnormality of the pelvic organs.

As mentioned earlier, no significant difference was found regarding the disorders detected by both EP and MR-D. However, this study had some limitation due to the small sample (19 patients), so an additional study with more participants might refute this assumption, especially in detecting rectoanal intussusception and increased dynamic perineal descent. In spite of a good specificity (87.5%), the sensitivity of MR-D in detecting rectoanal intussusception was low (36.4%), showing the inferior diagnostic capability compared with EP. The possibility of this outcomes might be due to the difference of the techniques between these two methods. Regarding MR-D, the patient had to defecate in the supine position, producing lower abdominal pressure compared with the physiologic sitting position of the EP method. In this study, we also increased the viscosity of the rectal contrast to compensate for the disadvantage of MR-D by mixing the potato starch with the Gadolinium compound. However, it seemed to be insufficient to increase the pushing out effort during evacuation to increase the ability to detect rectoanal intussusception.

MR-D could detect more cases of increased dynamic perineal descent compared with EP, which was the gold standard, but the specificity was fair (50%). This result might be due to the limitation of EP to demonstrate the reference line (pubococcygeal line, PC line) correctly which affected the result when diagnosing perineal descent. To improve this error, we could change the reference line using the sacrococcygeal joint instead, which would be easier to see. In addition, the study of Madill et al.[11] has contributed to this by pointing out that 66% of the participants in their trial showed movement of the coccyx during squeezing and straining. Therefore, to avoid the possibility of reference line repositioning, it was recommended to use the sacrococcygeal joint to draw the PC line.[11] However, this new reference line could increase the size of the perineal descent during resting, resulting in increased number of fixed perineal descent. The purpose of this research was to compare the diagnostic accuracy of MR-D with EP in assessing patients presenting chronic constipation. By reviewing the related literature, only the study of Matsuoka et al.[4] used a similar population group. In contrast, their MR-D technique was performed with the patient in the prone position without using the rectal contrast, which resulted in poor accuracy in detecting anterior rectocele and rectoanal intussusception.

The study of Pannu et al.[12] was conducted in a female population that required EP to evaluate the disorder of the pelvic floor and muscles. The duration between performing EP and MR-D did not exceed 9.5 months. The techniques in performing the EP of their study did not differ from our study using rectal and vaginal barium contrast. Unlike our study, the pulse sequence of MRI in the dynamic phase involved single–shot, fast-spin, echo sequences, TR infinite and TE 60 milliseconds, which were focused on T2 weighted images, so the rectal contrast constituted only ultrasound gel. The result of Pannu et al.'s study resembled our study by showing no difference between MR-D and EP in detecting anterior rectocele.

The study of Vitton et al.[13] was to evaluate the female patients presenting constipation by definition of Rome III criteria. The EP study was similar to the our study using barium contrast in the rectum and vagina, but the technique MR-D differed. The pulse sequence of MRI in the dynamic phase comprised steady–state free precession sequences, TR6.32 TE3.00, 1 image every 1.2 seconds, using ultrasound gel for rectal contrast. The sensitivity and specificity in detecting anterior rectocele were 81.6% and 85.7%, respectively, which was higher than that found in our study. In detecting the perineal descent, the sensitivity and specificity were 46.3% and 86.7 %, which was opposite to that found in our study. The cause seemed to be the difference in the definition of perineal descent . The perineal descent on EP referred to the position of the rectoanal angle, 2 cm below the pubococcygeal line (PC line) at rest or 3 cm below the PC line during defecation. Concerning MR-D, the perineal descents were determined wherever the anorectal angle was below the PC line. Moreover, the definition of how to make the pubococcygeal line was not mentioned in the article.

Conclusion

The MR-D was less sensitive than EP in detecting anterior rectocele and showed very low sensitivity in detecting rectoanal inussusception. It showed high sensitivity in detecting increased dynamic perineal descent but low specificity. This research demonstrated the superiority of EP in determining the causes of constipation over MR-D. However, the MR-D might be suitable in the case of suspected abnormalities in the anterior compartment of the pelvic organs, which could not be depicted by EP.

This study was limited in terms of the small sample and the discrepancy in making the reference line (PC line) during EP, which might have resulted in the diagnosis of perineal descent lower than reality.

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References

1. Mugie SM, Benninga MA, Di Lorenzo C. Epidemiology of constipation in children and adults: a systematic review. Best Pract Res Clin Gastroenterol 2011; 25: 3-18.
2. Denoya P, Sands DR. Anorectal physiologic evaluation of constipation. Clin Colon Rectal Surg 2008; 21: 114-21.
3. Goei R, Kemerink G. Radiation dose in defecography. Radiology. 1990; 176: 137-9.
4. Matsuoka H, Wexner SD, Desai MB, Nakamura T, Nogueras JJ, Weiss EG, et al. A comparison between dynamic pelvic magnetic resonance imaging and video-proctography in patients with constipation. Dis Colon Rectum 2001; 44: 571-6.
5. Solopova AE, Hetzer FH, Marincek B, Weishaupt D. MR defecography: prospective comparison of two rectal enema compositions. AJR Am J Roentgenol 2008; 190: W118-24.
6. Choi JS, Wexner SD, Nam YS, Mavrantonis C, Salum MR, Yamaguchi T, et al. Intraobserver and interobserver measurements of the anorectal angle and perineal descent in defecography. Dis Colon Rectum 2000; 43: 1121-6.
7. Jorge JM, Ger GC, Gonzalez L, Wexner SD. Patient position during cinedefecography: influence on perineal descent and other measurements. Dis Colon Rectum 1994; 37: 927-31.
8. Delemarre JB, Kruyt RH, Doornbos J, Buyze-Westerweel M, Trimbos JB, Hermans J, et al. Anterior rectocele: a ssessment with radiographic defecography, dynamic magnetic resonance imaging, and physical examination. Dis Colon Rectum 1994; 37: 249-59.
9. Jorge JM, Yang YK, Wexner SD. Incidence and clinical significance of sigmoidoceles as determined by a new classification system. Dis Colon Rectum 1994; 37: 1112-7.

10. Cappabianca S, Reginelli A, Iacobellis F, Granata V, Urciuoli L, Alabiso ME, et al. Dynamic MRI defecography vs. entero-colpo-cysto-defecography in the evaluation of midline pelvic floor hernias in female pelvic floor disorders. Int J Colorectal Dis 2011 2011; 26: 1191-6.
11. Madill S, Tang A, Pontbriand-Drolet S, Dumoulin C. Comparison of two methods for measuring the pubococcygeal line from sagittal-plane magnetic resonance imaging. Neurourol Urodyn 2011; 30: 1613-9.
12. Pannu HK, Scatarige JC, Eng J. Comparison of supine magnetic resonance imaging with and without rectal contrast to fluoroscopic cystocolpoproctography for the diagnosis of pelvic organ prolapse. J Comput Assist Tomogr 2009; 33: 125-30.
13. Vitton V, Vignally P, Barthet M, Cohen V, Durieux O, Bouvier M, et al. Dynamic anal endosonography and MRI defecography in diagnosis of pelvic floor disorders: comparison with conventional defecography. Dis Colon Rectum 2011; 54: 1398-404.