DOI: 10.21276/sjams.2017.5.3.90

Scholars Journal of Applied Medical Sciences (SJAMS) **ISSN 2320-6691 (Online)**
Sch. J. App. Med. Sci., 2017; 5(3F):1197-1203 **ISSN 2347-954X (Print)**

(An International Publisher for Academic and Scientific Resources)
www.saspublisher.com

Original Research Article

Sonoenteroclysis for Diagnosis of Small Bowel Diseases

Dr. Bindu T. K[1], Dr. Jayasree L[2], Dr. Rakul Nambiar. K[3], Dr. Manoj .T. Pillai[4]

[1]Resident, Department of Radiodiagnosis, Government Medical College Hospital, Trivandrum, Kerala 695011, India
[2]Associate Professor, Dept of Radiodiagnosis, Government Medical College Hospital, Trivandrum, Kerala 69011, India
[3]Resident, Department of Internal Medicine, Government Medical College Hospital, Trivandrum, Kerala 695011, India
[4]Associate Professor, Dept of Radiodiagnosis, Government Medical College Hospital, Trivandrum, Kerala 695011, India

***Corresponding author**
Dr. Jayasree L
Email: rakulnambiar@yahoo.com

Abstract: The aim of this study was to evaluate the effectiveness of sonoenteroclysis with administration of polyethylene glycol solution in the diagnosis and assessment of small bowel lesions in comparison with CT enteroclysis findings. Sonoenteroclysis followed by CT enteroclysis was done for 105 patients suspected to have small bowel pathology. The characteristics of small bowel lesions such as luminal narrowing and dilatation, fold thickening, wall thickening, stratification abnormalities, intraluminal masses, extraluminal abnormalities and extent of lesion were assessed on sonoenteroclysis and CT enteroclysis. The features of both investigations were analysed by Cohen's Kappa coefficient for statistical agreement. In this study, the overall sensitivity, specificity and accuracy of sonoenteroclysis obtained were 91%, 100% and 95.2% respectively for diagnosis of small bowel lesions. The sensitivity, specificity and accuracy were as follows - Luminal narrowing- 77%, 99%, 96% for jejunum; 100%, 99%, 96.4% for ileum, fold thickening- 69.3%, 98%, 85% for jejunum; 87%, 100%, 92.8% for ileum, wall thickening- 53%, 97.4%, 83.9% for jejunum; 82%, 100%, 87.5% for ileum, stratification abnormalities in the wall - 50%, 100%, 87% for jejunum; 80%, 100%, 98% for ileum, intraluminal masses - 75%, 100%, 98% for jejunum; 100%, 100%, 100% for ileum. The sensitivity, specificity and accuracy obtained were 92.8%, 98.9% and 98% respectively for a diagnosis of Crohn`s disease. There was very good agreement between the features of individual abnormalities in ileum and ileocaecal valve on sonoenteroclysis and CT enteroclysis. The diagnosis arrived in sonoenteroclysis had excellent agreement with that on CT enteroclysis. The overall diagnostic accuracy of sonoenteroclysis in detecting small bowel lesions is high. In ileum and at ileocaecal valve, it is comparable to that of CT enteroclysis. The possible clinical implication is that sonoenteroclysis can be an acceptable alternative to CT enteroclysis in paediatric population and young adults, pregnant patients and for follow up of chronic small intestinal diseases.

Keywords: Sonoenteroclysis, polyethylene glycol, CT enteroclysis

INTRODUCTION

The upper and lower gastrointestinal tract are easily accessible for endoscopy while the small intestine can be evaluated only by radiological methods. Though, ileoendoscopy and capsule endoscopy have been developed, these investigations did not gain popularity due to their incompleteness and limitations [1]. Barium studies still remain the initial investigation in small intestinal diseases with risk of considerable radiation exposure. Sonography was previously considered inappropriate for evaluation of the gastrointestinal tract due to presence of air in bowel which impedes the visualization. Sonographic visualization of the small bowel can be improved by directly infusing the bowel with water or non-absorbable, non-fermentable echo-poor liquids using a nasojejunal tube and a peristaltic pump. Sonoenteroclysis is a technique that combines the advantages of enteroclysis (distension of the small bowel) with high resolution, real-time ultrasound examination of the bowel. It is free of ionising radiation, cheap and repeatable; moreover it allows sequential visualisation of the small bowel assessing both morphological and functional aspects. The present study was done using PegLec {an isotonic anechoic electrolyte solution containing poly ethylene glycol (PEG)} which is a bowel-cleansing agent used for

preparation of endoscopic studies and is considered as the best contrast media for sonographic visualization of small bowel. Computerized tomographic (CT) enteroclysis was introduced as an alternative imaging method to overcome the individual deficiencies of CT (absence of distension of the small bowel) and conventional enteroclysis (absence of extraluminal information) and to combine their advantages into one technique. This method has been considered to be highly accurate in depicting mucosal and mural abnormalities as well as extraintestinal complications in bowel pathologies. In this study, patients who underwent sonoenteroclysis were immediately subjected to CT enteroclysis. Both images were analysed and compared, considering CT enteroclysis as the gold standard.

METHODOLOGY & TECHNIQUES

This was an observational study of patients who were referred to Radiodiagnosis department during the period of January 2013 to October 2013 for CT enteroclysis. Patients with history of diagnosed small intestinal disorders, bowel surgery and intestinal obstruction were excluded. CT enteroclysis was taken as the gold standard in the study. All patients were subjected to both sonoenteroclysis and the gold standard test (CT enteroclysis). A total of 105 patients were studied during the study period. A day prior to enteroclysis, the patients were instructed to consume low residue diet. The patients were asked to take mild laxatives (Hyoscine N butyl bromide) the previous night. On the day of the enteroclysis, only clear fluids were permitted. After insertion of naso-jejunal tube, patients were made to lie supine on the ultrasound couch and 1.2 litres of PEG solution was infused through the tube at a rate of 50 ml/minute [3, 4]. The PEG solution was prepared by dissolving 127.15 mg of PEG powder in two litres of water. High resolution bowel sonography was performed along with the infusion. The endpoint was the visualisation of passage of the ingested fluid through the terminal ileum into the caecum. If distension and visualization of the bowel were not adequate at any stage, further infusion of PEG was done. A total of 20- 25 minutes was required for the complete sonological examination in each patient .The examination was commenced with a convex 2-5 MHz transducer and for detailed evaluation, a linear 9 MHz transducer was used (IU 22; Philips). After sonoenteroclysis, patients were shifted from the ultrasound suite to the CT unit. An additional dose of 500 ml of PEG solution (at a flow rate of 80 ml/min) was infused to obtain optimal distension of the proximal jejunal loops during CT examination. CT scans were obtained on a Siemens Somatom Definition with a collimation of 0.6-mm and a pitch of 1. Scanning was started 20 seconds after intravenous infusion of 100 ml of non-ionic contrast medium at a flow rate of 4 ml/second during one breath-hold, from diaphragm to lower margin of pubic symphysis.

The criteria used for normal sonoenteroclysis was [5]

- Diameter of lumen: Normal jejunal diameter < 3 cm, ileal diameter < 2 cm
- Presence of peristalsis
- Fold thickness: 1.4 - 2mm.Number of folds per inch 4-7 in jejunum and 3-5 in ileum.
- Wall thickness: Normal wall thickness 3mm.Wall thickness more than 5mm in non-distended bowel and > 3 mm in distended bowel are considered abnormal
- Stratification of wall: There are 5 layers of bowel wall; Hyperechoic mucosa, hypoechoic muscularis mucosa, hyperechoic submucosa, hypoechoic muscularis propria and hyperechoic serosa.
- Extra intestinal abnormalities: Extra intestinal masses, lymph nodes, abscess, fistulas, diverticula and ascites.
- Intraluminal mass: Yes/no.
- Intussusception: Yes/no

The data was analysed using the statistical software SPSS 13.0 (Statistical Package for Social Sciences). CT enteroclysis was used as the gold standard for analysis in the study. Estimation of agreement between findings and diagnosis on sonoenteroclysis and CT enteroclysis was done by Cohen's Kappa co-efficient.

RESULTS

A total of 105 patients were included in the study. There were 59 males and 46 females with a mean age of 28 years. The distribution of small intestinal site involvement is shown in table 1. Ileal, ileoceceal and jejunal involvement was noted in 69.8%, 48.8% and 16.3% cases respectively. In 11.4% cases, jejunum was not properly assessed due to poor distension of lumen by oral contrast, tortuosity of loops as well as over-looping. Visualisation of small intestine on sonoenteroclysis is shown in table 2. Comparison of abnormalities on sonoenteroclysis in relation to CT enteroclysis is shown in table 3. CT enteroclysis correlation showed correct identification of abnormalities in ileum by sonoenteroclysis in 36 cases out of 41 abnormal cases. False positive diagnosis was made in four cases. Out of 65 cases reported normal on sonoenteroclysis, subsequent CT enteroclysis showed

abnormalities in ileal loop in five cases. The sensitivity, specificity and accuracy of sonoenteroclysis for detection of ileal abnormalities were 87.80%, 93.75% and 91.42% respectively. Sonoenteroclysis could detect jejunal lesions with a sensitivity of 68.18%, specificity of 89.16% and accuracy of 84.8%. For ileocaecal valve lesions, the sensitivity, specificity and accuracy obtained were 69.6%, 98.6% and 89.6% respectively. With sonoenteroclysis, the overall sensitivity, specificity and accuracy obtained were 91.07%, 100% and 95.2% respectively for diagnosis of small intestinal lesions. Sonoenteroclysis was most sensitive for detection of lumen and fold abnormalities (94.7 and 92.7 % respectively) whereas it was least sensitive for detection of loss of wall stratification (60.7% only). Statistical indices of sonoenteroclysis in the detection of intussusception were less reliable because the number of specific positive cases is small. Out of the 48 cases with normal sonoenteroclysis, 8 were false negative. Of them, 5 cases proved to be infective, two cases had extra-luminal pathology and one case had polyp. Sonoenteroclysis detected all cases of appendicitis (5 patients), lymph node enlargement (11 patients) and 13 out of 14 cases of Crohns disease. Sensitivity for detection of ileal lesions was better in comparison to jejunal lesions, whereas specificity was comparable. There were many cases in which visualization of jejunum was poor on sonoenteroclysis. Hence, estimation of agreement between jejunal findings on sonoenteroclysis and CT enteroclysis was not done. There was very good agreement (Kappa analysis) between the features of individual abnormalities in ileum and at ileocaecal valve on sonoenteroclysis and CT enteroclysis ($p<0.01$). The diagnosis arrived at, on sonoenteroclysis had excellent agreement with that on CT enteroclysis.

Table-1: Distribution of subjects according to site involved

Site of involvement	No of cases	Percentage
Jejunum only	5	11.7
Jejunum and ileum only	2	4.6
Ileum only	14	32.6
Ileum and ileoceceal valve only	14	32.6
Ileoceceal valve only	7	16.2
All involved	1	2.3
Total	43	100

Table-2: Visualisation of small intestine on sonoenteroclysis.

Small intestine	Well seen	Not well seen
Jejunum	93(88.6%)	12(11.4%)
Ileum	101(96%)	4(3.8%)
IC valve	104(99.1%)	1(0.9%)

Table-3: Abnormalities on sonoenteroclysis in comparison with CT enteroclysis.

Sonoenteroclysis		CT enteroclysis		Total
		Abnormal	Normal	
Jejunum	**Abnormal**	15	9	24
	Normal	7	74	81
Ileum	**Abnormal**	36	4	40
	Normal	5	60	65
IC Valve	**Abnormal**	23	1	24
	Normal	10	71	81
Small intestinal Pathology	**Abnormal**	51	0	51
	Normal	5	49	54

Table-4: Statistical analysis of variables on the sonoenteroclysis findings for the diagnosis of small bowel diseases compared to CT enteroclysis

Variables	Lumen abnormalities	Fold abnormalities	All	Stratification	Intaluminal mass	Extraluminal pathology	Intussusception
Sensitivity	94.7	92.7	89.4	60.7	80	83.02	100
Specificity	100	100	100	100	100	100	100
PPV	100	100	100	100	100	100	100
NPV	98.9	95.6	92.2	87.6	99	85.25	100
False +ve	0.0	0.0	0.0	0.0	0.0	0.0	0.0
False -ve	1.1	4.4	7.8	12.4	20	14.57	0.0
Accuracy	99.01	97.1	95.2	89.6	99	91.5	100

Table-5: Analysis of diseases entities detected by sonoenteroclysis compared to CT enteroclysis.

	Diagnosis	CT enteroclysis												
		N	I	C	L	T	A	E	S	LP	D	P	IN	Total
Sono-enteroclysis	N	40	5	0	0	0	0	2	0	0	0	1	0	48
	I	0	8	1	0	3	0	2	0	0	0	0	0	14
	C	0	1	13	0	0	0	0	0	0	0	0	0	14
	L	0	0	0	11	0	0	1	0	0	1	0	0	13
	T	0	0	0	0	2	0	0	0	0	0	0	0	2
	A	0	0	0	0	0	5	0	0	0	0	0	0	5
	E	0	0	0	0	0	0	3	0	0	0	0	0	3
	S	0	0	0	0	0	0	0	1	0	0	0	0	1
	LP	0	0	0	0	0	0	0	0	1	0	0	0	1
	D	0	0	0	0	0	0	0	0	0	1	0	0	1
	P	0	0	0	0	0	0	0	0	0	0	1	0	1
	IN	0	0	0	0	0	0	0	0	0	0	0	2	2
	Total	40	14	14	11	5	5	8	1	1	2	2	2	105

N-normal, I-infective/ inflammatory, C-Crohn`s disease, L-lymphadenopathy, T-tuberculosis, A- Appendicitis, E-Extraluminal pathology, S-stromal tumour, LP-lymphoma, D-diverticula, P-polyp, IN- intussusception.

Table-6: Sensitivity, specificity, and accuracy of sonoenteroclysis for detecting abnormalities in jejunum and ileum

	Jejunum			**Ileum**		
	Sensitivity	**Specificity**	**Accuracy**	**Sensitivity**	**Specificity**	**Accuracy**
Luminal narrowing	77%	99%	96%	100%	99%	96.4%
Fold thickening	64.3%	98%	85%	87%	100%	92.8%
Wall thickening	53%	97.4%	83.9%	82%	100%	87.5%
Stratification abnormality	50%	100%	87%	80%	100%	98%
Intraluminal mass	75%	100%	98%	100%	100%	100%

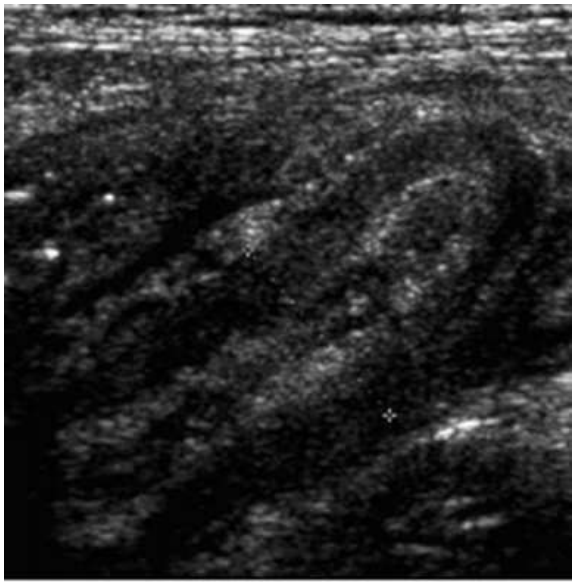

Fig-1: Longitudinal section of an acute perforated appendicitis

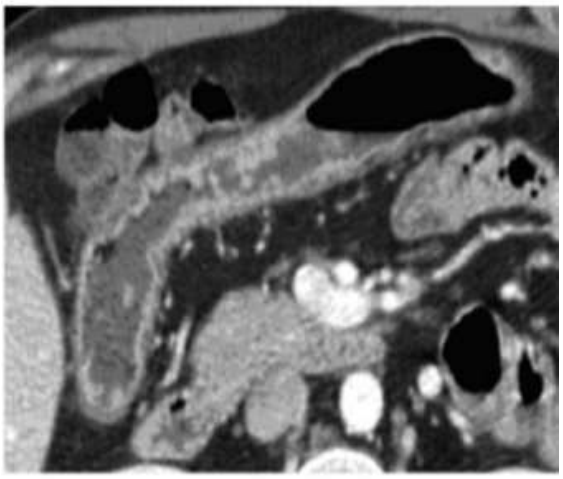

Fig-2: CT enteroclysis axial images showing psuedopolyps in crohn`s disease

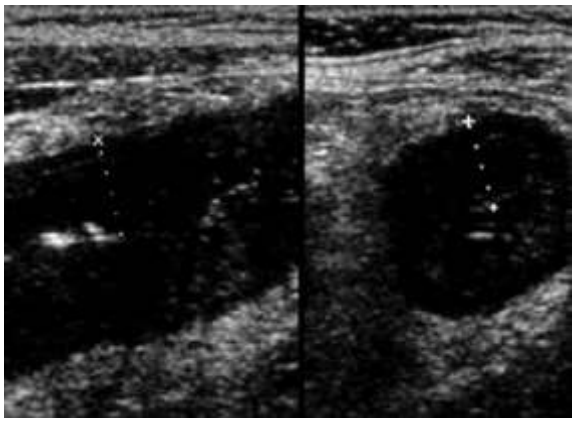

Fig-3: Disappearance of wall stratification in Crohn`s disease

DISCUSSION

Before the introduction of sonography, CT and MRI, luminal imaging with barium meal follow through and enteroclysis were the standard imaging modalities of small intestine. They had the inherent drawback of inability to image the extra-luminal components of various disease processes. Technical advance in the field of CT (particularly multidetector CT technology) led to the introduction of CT enteroclysis and subsequently, CT enteroclysis became the imaging modality of choice. The conventional barium enteroclysis is likely to become an obsolete procedure in near future. However, CT enteroclysis has drawbacks like radiation exposure and unsuitability for paediatric and pregnant patients. The evaluation of small bowel after administration of an ingested water load has been practised since the introduction of sonography. Some radiologists practice the time consuming method of following the advancing head of water column in the small intestine by ultrasound similar to following the advancing head of barium column by fluoroscopy. Water being absorbable, optimal distension of small bowel loops was not possible. The introduction of new isosmotic, non-fermentable, non-absorbable, anechoic electrolyte solutions like those containing PEG has made sonoenteroclysis easier and more rewarding in terms of yield of abnormal findings. The administration of fluid through nasogastric tube directly into the small intestine further adds to the distension and thus visibility of the bowel on sonography. To the best of our knowledge, there is no study comparing the diagnostic yield of sonoenteroclysis with CT enteroclysis. CT enteroclysis is expected to be superior to sonoenteroclysis because of better cross sectional imaging features, ability to interrogate areas inaccessible to sonography and ability to study intravenous contrast enhancement properties. The present study did not attempt to compare the efficacy, usefulness and diagnostic performance of sonoenteroclysis and CT enteroclysis with the final diagnosis from histopathology or long-term clinical follow up of the patient. Instead, this was a pilot study to ascertain how abnormal findings obvious on CT enteroclysis would be picked up on sonoenteroclysis with a view to study, in future, the clinical usefulness of the latter in patients who are not ideal candidates for CT enteroclysis. Thus, the study looked into the detection of abnormal findings by sonoenteroclysis in patients who underwent CT enteroclysis for suspected small bowel pathology. No time delay was allowed between the two procedures.The assessment of small bowel after oral administration of PEG solution has been shown to be highly accurate in most studies with a median sensitivity of 97.1% and a specificity of 97%. Fifteen studies used PEG to evaluate the small intestine, three of which used infusion into the small bowel with a nasojejunal tube and a peristaltic pump. As per the available literature, use of PEG slightly improved the detection of Crohn's disease, as well as in the post-operative follow-up of the same. It seemed to offer a greater advantage over conventional bowel sonography in detecting proximal small bowel lesions of Crohn's disease (100% sensitivity with sonoenteroclysis, 80% sensitivity with sonography). In the present study, the sensitivity of sonoenteroclysis for proximal small bowel lesions of Crohn`s disease was 92.8%.Sonoenteroclysis could detect ileal lesions better than jejunal lesions with regard to luminal narrowing, fold thickening, wall thickening, stratification abnormalities and intraluminal masses. This finding is consistent with a similar study where bowel ultrasound had sensitivity reaching 97%, and disease of the terminal ileum was the most easily detected site [6].The sensitivity, specificity and accuracy for luminal narrowing, fold thickening, wall thickening, stratification and intraluminal masses were calculated separately. The sensitivity, specificity and accuracy of sonoenteroclysis were 91%, 100% and 95.2% respectively for diagnosis of small bowel lesions. Positive predictive value (PPV) was 100% and negative predictive value (NPV) 90.74%. False negative cases constituted 9.2%. When overall sensitivity, specificity, accuracy, PPV and NPV of sonoenteroclysis compared to CT enteroclysis were calculated, there was a likely chance for misclassification error, as there was the chance of classifying a patient as true positive when positive for a specific lesion at one specific site and also when positive for a different lesion at the same site or different site. This likely error was avoided by calculating statistical indices for individual specific lesions at specific sites.

Limitations of the study:

- Sample size was small when statistical analysis was done for specific types of diseases and in specific sites.
- Patients with acute intestinal obstruction were not included in this study.
- In situations where sonoenteroclysis performed better than CT enteroclysis may produce misclassification error as in statistical calculation. The correctly identified lesions by sonoenteroclysis which were not detected by CT enteroclysis will be placed in false positive column because we are calculating sensitivity, specificity, PPV and NPV by taking CT enteroclysis as a gold standard and this occurs in situations where we are not using perfect

gold standard due to logistic reasons as in present study.

CONCLUSION

The possible clinical implication of the conclusions of this study is that sonoenteroclysis can be an acceptable alternative to CT enteroclysis in paediatric population and young adults. It should be taken as the imaging of choice in pregnant or possibly pregnant patients. When used for follow up studies, sonoenteroclysis can bring down the total number of CT examinations in chronic illnesses like inflammatory bowel diseases and paediatric patients to bring down significantly the cumulative radiation dose.

REFERENCES

1. Voderholzer WA, Beinhoelzl J, Rogalla P, Murrer S, Schachschal G, Lochs H, Ortner MA. Small bowel involvement in Crohn's disease: a prospective comparison of wireless capsule endoscopy and computed tomography enteroclysis. Gut. 2005 Mar 1; 54(3):369-73.
2. Sailer J, Peloschek P, Schober E, Schima W, Reinisch W, Vogelsang H, Wunderbaldinger P, Turetschek K. Diagnostic value of CT enteroclysis compared with conventional enteroclysis in patients with Crohn's disease. American Journal of Roentgenology. 2005 Dec; 185(6):1575-81.
3. Mazzeo S, Caramella D, Battolla L, Melai L, Masolino P, Bertoni M, Giusti P, Cappelli C, Bartolozzi C. Crohn disease of the small bowel: spiral CT evaluation after oral hyperhydration with isotonic solution. Journal of computer assisted tomography. 2001 Jul 1; 25(4):612-6.
4. Folvik G, Bjerke-Larssen T, Ødegaard S, Hausken T, Gilja OH, Berstad A. Hydrosonography of the small intestine: comparison with radiologic barium study. Scandinavian journal of gastroenterology. 1999 Jan 1; 34(12):1247-52.
5. Nagi B, Rana SS, Kochhar R, Bhasin DK. Sonoenteroclysis: a new technique for the diagnosis of small bowel diseases. Abdominal imaging. 2006 Aug 1; 31(4):417-24.
6. Parente F, Maconi G, Bollani S, Anderloni A, Sampietro G, Cristaldi M, Franceschelli N, Bianco R, Taschieri AM, Porro GB. Bowel ultrasound in assessment of Crohn's disease and detection of related small bowel strictures: a prospective comparative study versus x ray and intraoperative findings. Gut. 2002 Apr 1; 50(4):490-5.