The privilege of I- SCAN over white light Endoscopy in the diagnosis of Portal HypertensiveGastropathy in an Egyptian population.

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Abstract

Background: Endoscopic imaging of Portal Hypertensive Gastropathy (PHG) depends on white light endoscopy (WLE). Sometimes WLE may miss many lesions and may cause misinterpretation of findings, leading to delayed or inefficient therapeutic modalities. The aim was to assess the privilege of using I-SCAN over conventional WLE in the diagnosis of PHG among liver cirrhosis patients. One hundred fifty-three patients with cirrhosis and portal hypertension were examined endoscopically with both conventional WLE and I-SCAN modes (1, 2 &3).

Results: I-SCAN modes were able to define PHG with higher cut off value for the platelets count and lower cut off values for Portal Vein diameter and splenic size. I-SCAN 2 &3 almost share the ability to detect the red color of the blood vessels, capillaries and submucosal hemorrhage. All I-SCAN modes showed statistically significant difference against WLE in detection of mosaic pattern in fundus of the stomach ($P<0.001$) with both I-SCAN 1 &2 having the highest true positive rate (95.3%). I-SCAN 2 was the best mode to detect mosaic pattern compared to WLE and other I-SCAN modes with sensitivity 95.3%, specificity 51.9% and accuracy 87.7%. Regarding red spots detection, I-SCAN 2 was the only mode with statistically significant difference against WLE. Although, I-SCAN 3 had the highest true positive rate (75.6%) versus (69.3%) for I-SCAN 2. Both I-SCAN 2 &3 shared sensitivity value 100%. But; regarding the specificity I-SCAN 2 was 52.8% against 39.6% for I-SCAN 3. I-SCAN 3 detected more positive cases with red spots of PHG (72.1%) than WLE and other I-SCAN modes. Regarding the severity both I-SCAN 2 &3 detected the same number of cases with severe red spots (16.9%).

Conclusions: I-SCAN 2 is considered a better visualizing modality for PHG and its criteria (mosaic pattern & red spots) in gastric mucosa. Combining magnification technique with I-SCAN functionality could enhance the diagnostic ability depending on the gastric mucosal pit patterns and comparing it to the patterns associated with other diseases.

Introduction

Cirrhosis leads to abnormalities in multiple vascular beds. There is vasoconstriction in the liver and the kidneys, but also vasodilation in the other vascular beds, like in the periphery, lungs, brain, and mesentery. The derangement in each of these beds leads to specific clinical disease. The vasoconstrictive phenotype in the liver is due to the imbalance of vasoconstrictive and vasorelaxing molecules and it causes clinical portal hypertension (1).

Portal hypertension may lead to various mucosal changes all over the GI tract, which may lead to bleeding either chronic or, more rarely, acute. These changes often affect the stomach mainly and rarely may affect the duodenum or the rest of the small intestines, and the colon (2).

The diagnosis of PHG is typically established according to endoscopic criteria. The characteristic findings include a snake skin mosaic pattern appearing on the mucosal surface, with or without red or black-brown spots, found mainly in the proximal parts of the stomach. The density and distribution of the spots that

coexist with the mosaic mucosa helps in classifying PHG as mild if there is none to few spots or severe in the presence of many to extensive spots (3).

I-SCAN is a dynamic image enhancement technology based on software algorithms that can enhance the endoscopic view regarding both the texture and architecture of the mucosal surface and vascular network. I-SCAN has three default settings: I-SCAN 1, I-SCAN 2, and I-SCAN 3 (4).

The key modes of I-SCAN technology are three modes of image enhancement, including surface enhancement (SE), contrast enhancement (CE), and tone enhancement (TE). SE depends on enhancing the contrast between light and dark, and CE digitally adds blue hue to darker areas, by analyzing data from incoming endoscopic signals about luminance intensity for every pixel. Applying SE and CE while examining the mucosal surface helps in detailed observation of fine irregularities. TE analyzes each one of the RGB components in the conventional endoscopic image then recombines the color frequencies of each component to enhance subtle mucosal structures with fine color changes (5).

The surface enhancement mode shows mucosal details by revealing the boundaries of small glands and lesions. This mode has 3 levels of image enhancement: low, medium, and high. The contrast enhancement mode displays images obtained using blue light coming through the white light, consisting of blue, green, and red light to the foreground and reveals the superficial pattern and vascular pattern in a way similar to that of NBI. The contrast enhancement mode also has 3 levels and is based on images obtained using blue, green, and red light. Three tone-enhancement options can be used to image the esophagus, stomach, and colon separately (6).

I-SCAN technology helps in increasing the diagnostic accuracy by revealing fine details of the GI mucosa. I-SCAN is a software-based imaging method unlike NBI which uses the contrast created by light of different wavelengths and unlike traditional chromoendoscopy, no dye or contrast material is used (7).

I-SCAN with its different modes can be used to diagnose PHG by detecting the diagnostic criteria (Mosaic Pattern and Red Spots) as White light endoscopy can miss the fair changes or the flat nature of PHG lesions specially in early phases of the disease which may make a misdiagnosis of the lesions hence neglecting a considerable source of upper GI bleeding.

Aim Of The Work

Data on the validation of the use of I-Scan particularly over white light endoscopy in diagnosis of PHG and its severity is scarce.

The aim of this study is to assess the advantages of using I-SCAN over conventional white light endoscopy in the diagnosis of Portal Hypertensive Gastropathy among liver cirrhosis patients.

Patients And Methods

This is a hospital based cross sectional study that was conducted on liver cirrhosis patients with Portal Hypertension associated Portal Hypertensive Gastropathy. The enrolled patients were selected from the

attendants of Endoscopy Unit at Specialized Medical Hospital, Mansoura University during year 2017–2018 after approval of Medical Ethics and Research Committee at Mansoura University. The study was performed according to the ethical standards for human experimentation and in accordance with the ethical principles of the 1975 Declaration of Helsinki. An informed consent was obtained from all patients after explanation of the research and all procedures were done. All procedures performed in this study were in accordance with the standers of Research Ethics Committee (REC) of the Faculty of Medicine; Mansoura University (MS/17.06.87)

The included patients were 18 years and older from both sexes with liver cirrhosis whatever the etiology and having evidence of portal hypertension (clinical, laboratory, radiological or endoscopic findings). We excluded patients with active Upper GI bleeding or receiving medications to reduce portal pressure or receiving medications that can affect gastric mucosa (e.g: NSAIDs, Aspirin, Anti platelet …etc), as well as patients with end stage organ failure (Renal, Cardiac) or advanced malignancy.

Assessing the stage of liver cirrhosis by patient's history, clinical examination and laboratory investigations, we then used these data to classify the patients according to Child-Pugh, MELD, APRI and Fib-4 scores.

Laboratory investigations: CBC, Liver function tests (S. Albumin, S. Bilirubin, AST, ALT and INR), S. Creatinine, HCV Ab, HB sAg and IHA for Bilharziasis.

Abdominal ultrasound was performed to detect signs of liver cirrhosis and PH; portal vein diameter, liver cirrhosis, size of spleen, presence of collaterals and ascites.

Endoscopic examination was done using both Conventional white light endoscope (WLE) to assess the presence of esophageal varices, gastric varices & PHG in the Fundus, Body and Antrum of the stomach. During the same endoscopy session, we initiate I-SCAN functionality on Pentax EPK-i5000 processor to apply digital contrast and enhancement to the image then we shift and cycle through different I-SCAN modes (1, 2 & 3) by pressing the buttons on the processor for visualization of the lesions and reassessment of the PHG findings. Four images were obtained from fundus of the stomach, sequentially capturing normal white light endoscopic view, I-SCAN 1, I-SCAN 2 then I-SCAN 3**(Fig. 1).**

The images were collected and inspected furthermore to score out the morphological endoscopic criteria of PHG according to the Baveno Scoring System (8); the presence of a mosaic pattern and/or red spots and each item is described individually in each image obtained during the endoscopy**(Fig. 2).**

Each item is described either Absent, Mild or Severe. The grading of mosaic pattern is considered according to the density of the reticulations and its color. Mild mosaic pattern denotes less dense reticulations and/or pink color of the pattern. While severe mosaic pattern is marked when there are more dense reticulations and/or reddish pattern. Red spots are described mild if isolated or separate and severity is expressed if confluent or hemorrhagic spots**(Fig. 3).**

Statistical analysis

Data were fed to the computer and analyzed using IBM SPSS software package version 22.0. Qualitative data were described using number and percent. Quantitative data were described using median (minimum and maximum) for non-parametric data and mean, standard deviation for parametric data after testing normality using Kolmogrov-Smirnov test. Significance of the obtained results was judged at the (0.05) level.

Results

The demographic data of the studied patients showed that their age is ranging between 40 and 74 years old. Among the total 154 patients, 93 (60.4%) of them are males and 61 (39.6%) are females. Regarding the cause of liver cirrhosis and portal hypertension, Hepatitis C infection is present in 137 patients (89%), pure HCV infection in 128 patients (83.12%) and mixed infection of HCV and Bilharziasis in 9 patients (5.85%). HBV infection is present in 5 patients (3.2%).

Most of the studied patients are classified as Child B (80, 51.9%). While Child A is presented by (62, 40.3%) and only (12, 7.8%) of the patients are Child C. All the studied patients have median APRI score of 1.17 with minimum 0.3 and maximum 26.57 but most of them (52.6%) have score ranging between 0.5 and 1.5. Regarding the Fib-4 score its values are ranging from 1.3 up to 60.54 with median value of 3.5 but the median value of MELD score is 10 ranging from 3 up to 25.

Table (1) shows a statistically significant difference between WLE and all I-SCAN Modes in detection of mosaic appearance in the fundus. True positive rate is 95.3% as detected by I-SCAN 1 & 2 while I-SCAN 3 has lower true positive rate (92.9%). Also, there's a statistically significant difference between WLE and I-SCAN 2 regarding detection of red spots in the fundus while I-SCAN 1&3 show no statistically significant difference when compared to WLE. The highest True positive rate was detected for I-SCAN 3 followed by I-SCAN2 and the least value was for I-SCAN 1 (75.6, 69.3 & 37%, respectively).

Table (2) demonstrates that only Child Pugh score and APRI score have achieved significant correlation with mosaic pattern seen in fundic mucosa by WLE.

The comparison between the platelet counts in cases with present mosaic pattern versus those with red spots seen by standard WLE examination denotes that red spot are related to lower platelet count hence more severe disease and elevated PH.

In standard WLE examination, the presence of red spots is related to larger splenic diameter as detected by abdominal ultrasonography representing more elevation of portal pressure and more severity of the disease despite not achieving a statistically significant correlation. This doesn't apply to association with mosaic pattern presence.

Table (3) demonstrates the association between PHG criteria seen by I-SCAN1 with different patients' data and only APRI score has achieved association with mosaic pattern presence in the fundus of the stomach.

Regarding mosaic pattern and platelet count we found that both I-SCAN 1 & 2 share the highest platelet count with cut off mean value (99.82 ± 48.48) by a small margin of superiority over WLE (99.75 ± 49.63).

Table (4) shows a statistically significant association between APRI score and both mosaic pattern and red spots detected by I-SCAN 2.

Also INR value and splenic diameter both show association only with red spots in fundic mucosa while examined by I-SCAN 2.

I-SCAN modes related to higher cut off values of platelet count in patients with present red spots indicating better ability and sensitivity of I-SCAN modes to detect red spots earlier. I-SCAN 2 has the highest mean value of platelet count cut off (100.93 ± 52.26).

Table (5) demonstrates significant association between the detection of mosaic pattern by I-SCAN 3 and platelets count. While the presence of red spots is associated with INR value and splenic diameter.

Child Pugh score, APRI score and Fib4 score have achieved significant correlation with mosaic pattern seen by I-SCAN 3. Only APRI score has achieved statistically significant association with red spots seen by I-SCAN 3.

I-SCAN 3 detection of red spots is associated with smaller diameter of PV (13.37 ± 2.61) representing the ability of this mode to detect red spots in earlier stages of the disease compared to the other techniques used in examination.

Table (6) regarding mosaic pattern detection shows that both I-SCAN 1 & 2 have the same kappa agreement value (0.525) which is considered fair agreement & I-SCAN 3 has 0.475 kappa agreement. Both I-SCAN 1 & 2 share the same values of sensitivity (95.3%), PPV (90.3%), NPV (70%) and Accuracy (87.7%) which are higher than I-SCAN 3. All I-SCAN modes have the same specificity value (51.9%).

And regarding red spots detection it shows that the highest Kappa agreement was 0.882 for I-SCAN1 which is considered good agreement. While the highest sensitivity value is detected for both I-SCAN 2 &3 100% for each and regarding the specificity I-SCAN 2 has higher value than I-SCAN 3 (52.8% &39.6%) respectively but I-SCAN 1 shows the highest specificity 94.3%.

Examples for endoscopic findings in our study:

Discussion

PHG is an important sequalae of portal hypertension and can lead to chronic blood loss with resultant refractory anemia and even liver transplantation. Blood flow congestion resulting from portal hypertension by different mechanisms is considered the main cause of PHG. This leads to imbalances between mucosal defense and injury factors caused by mucosal hemodynamic alterations thus inducing PHG (9).

Higher prevalence of PHG is found in patients with severe PH, advanced liver disease, and after esophageal varices eradication. On the other side, PHG patients with cirrhosis showed low incidence of acute GI bleeding; incidences ranged from 2.5 to 30%, with the greatest occurrences being reported in patients with severe PHG (10).

PHG is diagnosed mainly by upper GI endoscopy as it is seen in gastric mucosa as characteristic mosaic-like pattern with or without red spots. The pathogenesis of PHG was proven to involve venous congestion with gastric mucosal capillary dilation (11).

I-SCAN is a new technology based on software filter that digitally enhances high-definition endoscopic images and renders color tone, sharpness, and contrast. Three algorithms of I-SCAN can be used to get the desired the level of enhancement: Surface Enhancement enhances light-to-dark contrast for easier demarcation of edges and flat lesions, Contrast Enhancement enhances areas of low intensity for better identification of depressed lesion and Tone Enhancement for improved mucosal structure assessment by increasing the illumination and emphasis on vascular features (12). These algorithms are combined to give three I-SCAN settings used as follows: I-SCAN 1 to detect the lesions where only SE is applied to refine the subtle surface abnormalities without altering the brightness. I-SCAN 2 mode is used for characterization of lesions by combining SE and TE to enhance both minute mucosal changes and vessel structures. I-SCAN 3 adds CE to the endoscopic image with SE and TE and it helps in demarcation of lesions by digitally adding blue color to its darker edges (13).

The aim of this study was to assess the privilege of using I-SCAN over conventional white light endoscopy in the diagnosis of Portal Hypertensive Gastropathy among liver cirrhosis patients

All I-SCAN modes (1, 2 &3) showed statistically significant difference against WLE in detection of mosaic pattern in fundus of the stomach ($P < 0.001$) with both I-SCAN 1 &2 having the highest true positive rate (95.3%). This gives us the conclusion that I-SCAN 2 is the best mode to detect mosaic pattern compared to WLE and other I-SCAN modes with sensitivity 95.3%, specificity 51.9% and accuracy 87.7%.But; Achim et al., (2016); results come against our conclusion as they reported that I-SCAN 2 got lower accuracy than I-SCAN 1 in diagnosing mosaic pattern.

Cross tabulation of WLE red spots findings versus different I-SCAN modes findings shows that I-SCAN 2 is the only I-SCAN mode to have statistically significant difference against WLE. Although, I-SCAN 3 had the highest true positive rate (75.6%) versus (69.3%) for I-SCAN 2. Both I-SCAN 2 &3 shared sensitivity value 100% but regarding the specificity I-SCAN 2 got 52.8% against 39.6% for I-SCAN 3. Regarding the red spots examination, I-SCAN 3 detected more positive cases with red spots of PHG (112, 72.1%) than WLE and other I-SCAN modes and regarding the severity both I-SCAN 2 &3 detected the same number of cases with severe red spots (26, 16.9%).

The results of (14) agree with our results pointing to the ability of I-SCAN 2 to better detect red spots of PHG but our study was expanded to the use of I-SCAN 3 which was able to detect more cases of severe PHG by numbers as proved by the high true positive rate despite not achieving statistically significant difference against WLE as in the case of I-SCAN2.

Other studies were interested in the role and efficacy of virtual chromoendoscopic modalities in the diagnosis of PHG like (15) that used NBI with magnification to correlate and explain the WLE PHG findings with the observed microcirculation changes. His results concluded that NBI has higher accuracy than WLE in detection of PHG with lower cut off values of different non-invasive predictors of PHG. Also (16) used both

NBI and I-SCAN with magnification to correlate the microcirculatory findings with the histopathological findings and concluded that I-SCAN detected the same number of cases with mild PHG but more cases with severe PHG than WLE. In this study NBI detected the same number of cases with severe PHG but milder PHG cases than WLE &ISCAN. This gives NBI the advance over I-SCAN in detection of mild PHG hence early detection and treating the condition before proceeding to the complications related to its severity.

A study of microvascular architecture of PHG related to the presence of red spots with intramucosal hemorrhage found that Low platelet count and the resulting bleeding tendency may contribute to intramucosal hemorrhage in the pathogenesis of PHG leading to the morphological appearance of red spots as an endoscopic finding (11).

The median value of platelets count in the included patients in our study was 93 ($\times 10^3/\mu L$) ranging from 27 up to 211.

Another study reported the findings of PHG in 448 out of 611 patients (73.3%) with mean value of platelets count 107 ± 66(17). While Gjeorgjievski and Cappell demonstrated the inverse correlation between the severity of PHG and platelets count as patients with mild PHG had platelets count mean value 132 ± 100.7 and count with severe PHG = 102.8 ± 68.8.(18) Also ;Mandhwani and his colleauges in their study mentioned that the mean platelets count in the studied population was 113.91 ± 69.02(19).

The comparison between the platelet counts in patients with mosaic pattern versus those with red spots seen by standard WLE examination denotes that red spots are related to lower platelet count hence more severe disease and elevated PH.

I-SCAN modes related to higher cut off values of platelet count in patients with present red spots indicating better ability and sensitivity of I-SCAN modes to detect red spots earlier. I-SCAN 2 has the highest mean value of platelet count cut off (100.93 ± 52.26).

Regarding mosaic pattern and platelet count we found that both I-SCAN 1 &2 share the highest platelet count cut off mean value (99.82 ± 48.48) by a small margin of superiority over WLE (99.75 ± 49.63).

As regard portal vein diameter, associations between PV diameter measured by abdominal ultrasonography and PHG criteria found by all used endoscopic techniques (WLE, I-SCAN 1, 2 &3) didn’t show any significant correlation.

Normal PV diameter is less than 10 mm, with a greater than 20–30% increase with food and respiration. In portal hypertension, the PV is dilated (> 13 mm), with absent or less than 20% variation with respiration as reported by Elbarbary and his colleauges(20). The patients enrolled in their study achieved highly significant increase in the PV diameter compared with the controls with mean value 14.2 ± 1.6 mm in the patient group as an indicator of PH.

I-SCAN 3 detection of red spots is associated with smaller diameter of PV (13.37 ± 2.61 mm) representing the ability of this mode to detect red spots in earlier stages of the disease compared to the other techniques used in examination.

Mosaic pattern association with PV diameter didn't show any significant difference with all endoscopic techniques as the smallest diameter (13.59 ± 2.46 mm) with WLE and the largest diameter (13.64 ± 2.41 mm) with I-SCAN 3 with 0.5 mm difference in the mean value.

The presence of red spots in standard WLE examination is related to larger splenic diameter as detected by abdominal ultrasonography representing more elevation of portal pressure and more severity of the disease despite not achieving a statistically significant correlation. In contrast this doesn't apply to association with the presence of mosaic pattern.

Kim and his colleagues reported statistically significant association between the severity of PHG and splenic diameter as patients with severe PHG had splenic diameter of 13.1 ± 2.4 cm while the splenic diameter with mild PHG was 12.2 ± 2.5 cm, and splenic diameter in cases without PHG was 10.7 ± 2.9 cm (21). While Mandhwani and his colleauges reported the splenic diameter among their studied population with mean value 14.65 ± 3.18 cm (19).

Splenic size shows significant correlation ($p < 0.05$) with red spots detection using I-SCAN 2 ($p = 0.011$) and I-SCAN 3 ($p = 0.047$). While detecting red spots both modes (I-SCAN 2 &3) are related to lower cut off mean values of spleen diameter (15.47 ± 4.43 cm, 15.7 ± 4.57 cm respectively) compared to WLE (16.91 ± 2.25 cm) representing its ability to identify red spots in earlier stages of the disease that correlates with less severe PH.

The higher values of splenic diameter found in our patients compared to Kim and his colleauges' study could be justified as the Egyptian population have their own parameters regarding the ultrasonographic organometery which are higher than those recorded by other studies as reported by El Sharkawy and his colleauges (22).

As regards the different scoring systems applied to the population of our study and its correlation to the PHG criteria found by different endoscopic techniques; we found that **Child Pugh score** got a statistically significant association only with mosaic pattern detected by WLE & me-SCAN3. **APRI score** achieved statistically significant correlation with mosaic pattern detected with WLE & I-SCAN 1. Also, with both mosaic pattern and red spots detected with I-SCAN 2 &3. Regarding **Fib-4 score**, mosaic pattern detected with I-SCAN 3 was the only category that achieved statistically significant association. **MELD score** couldn't achieve any significant correlation with any of the findings by all the endoscopic techniques.

Conclusions

PHG is considered an important cause of upper GI bleeding in cases with PH. The data of our study shows that red spots appeared more in the fundus while the mosaic pattern appeared more in the body of the stomach. I-SCAN technique gives us better ability to detect the mucosal changes. I-SCAN 2 is considered a better visualizing modality for PHG and its criteria (mosaic pattern and red spots) in gastric mucosa. Combining magnification technique with I-SCAN functionality could enhance the diagnostic ability depending on the gastric mucosal pit patterns and comparing it to the patterns associated with other

diseases. Further assessment of other I-SCAN modes is recommended to get the most of it during the examination by switching between the different modes.

Abbreviations

PHG: Portal hypertensive gastropathy

SE: Surface enhancement

TE: Tone enhancement

NBI: Narrow band imaging

PV: Portal vein

WLE: White light endoscopy

CE: Contrast enhancement

RGB: red, green and blue

GI: Gastrointestinal

Declarations

ETHICS APPROVAL AND CONSENT TO PARTICIPATE

This study was performed according to the ethical standards for human experimentation and in accordance with the ethical principles for the 1975 Declaration of Helsinki. All patients included in this study signed an informed written consent to participate after explanation of the research and all procedures that were done. All procedures performed were in accordance with the standards of the Research Committee (REC) of the Faculty of Medicine Mansoura University.

AVAILABILITY OF DATA AND MATERIALS

The datasets used and/or analyzed during the current study are available from the corresponding author on reasonable request.

COMPETING INTERESTS

Not applicable.

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AUTHOR`S CONTRIBUTIONS

The corresponding author had proposed the subject for research and had outlined the study design as well as conducted the final revision of the gathered data. All authors shared in selection of patients, collecting the clinical data and endoscopic procedures. Also; they had prepared the manuscript. All authors had read and approved the final manuscript.

CONFLECT OF INTEREST DISCLOSURE:

The authors declare that they have no competing interests.

PERMISSION TO REPRODUCE MATERIAL FROM OTHER SOURCES

Not applicable.

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References

1. ROCKEY, D. 2017. The Molecular Basis of PorTal hyPerTension. Transactions of the American Clinical and Climatological Association, 128, 330.
2. PRIMIGNANI, M. & TOSETTI, G. 2016. Portal hypertensive gastropathy after variceal eradication: more bleeding risk or just more reddening? *Hepatology International* volume 10, pages 847–850.
3. PLEVRIS, J. N., HAYES, P. C., KAMATH, P. S. & SONG, L.-M. W. K. 2017. *Endoscopy in Liver Disease*, John Wiley & Sons. ISBN: 978-1-118-66087-4 December *2017.*
4. PENTAX MEDICAL 2013. PENTAX i-SCAN™ Functionality, Application, and Technical Analysis: Technical Whitepaper. PENTAX Medical.
5. KANG, H., HONG, S., KIM, Y., PARK, H., KIM, B., LEE, J., KIM, S., LEE, T., KIM, J., LEE, S., SUNG, I. & SHIM, C. 2013. The efficacy of i-SCAN for detecting reflux esophagitis: a prospective randomized controlled trial. Dis Esophagus, 26, 204–211.
6. ANANDASABAPATHY S., CARLOS R.&Morris J. 2014. PENTAX medical i-SCAN technology for improved endoscopic evaluations: special report.Gastroenterol Endoscopy News. https://www.endoscopy-world.com
7. AKARSU, M. & AKARSU, C. 2018. Evaluation of New Technologies in Gastrointestinal Endoscopy. JSLS: Journal of the Society of Laparoendoscopic Surgeons, Jan-Mar; 22(1) doi: 10.4293/JSLS.2017.00053.
8. DE FRANCHIS, R. 2010. Revising consensus in portal hypertension: report of the Baveno V consensus workshop on methodology of diagnosis and therapy in portal hypertension. Journal of hepatology, 53, 762–768.
9. BANG, C., KIM, H., SUK, K., KIM, S., PARK, J., PARK, S., KIM, H., JANG, M., PARK, S. & LEE, M. 2016. Portal hypertensive gastropathy as a prognostic index in patients with liver cirrhosis. *BMC gastroenterology*, 16, 93.

10. GAMIE, S. 2018. Portal Hypertensive Gastropathy (PHG). *Stomach Disorders.* IntechOpen.
11. HAYASHI, S. & SAEKI, S. 2007. Endoscopic microvascular architecture of the portal hypertensive gastric mucosa on narrow band imaging. Digestive Endoscopy, 19, 116–123.
12. CODA, S. & THILLAINAYAGAM, A. 2014. State of the art in advanced endoscopic imaging for the detection and evaluation of dysplasia and early cancer of the gastrointestinal tract. Clinical and experimental gastroenterology, 7, 133.
13. NEUMANN, H., FUJISHIRO, M., WILCOX, C. & MONKEMULLER, K. 2014. Present and future perspectives of virtual chromoendoscopy with i-scan and optical enhancement technology. Dig Endosc, 26 Suppl 1, 43–51.
14. ACHIM, A., VESA, S. & DUMITRU, E. 2016. The Efficacy of Virtual Chromoendoscopy in the Diagnosis of Portal Hypertensive Gastropathy. J Gastrointestin Liver Dis, 25, 289–293.
15. EL SHAZLY, Y. M., SAID, H., RAFIK, M. M., KEDDEAS, M. W., ELSAYED, E. Y. & RASMY H. 2014. Narrow Band Imaging: A New Tool for Diagnosis of Portal Hypertensive Gastropathy. Nat Sci, 12, 40–7.
16. YOUSRY A.; SHEHAB H.;RAGAB K.; EL-GHANAM M; GODA M.;ABDALLA H.; ABOUSHOUSHA T.& HELAL N. 2018. Role of I-Scan in the Diagnosis of Patients with Portal Hypertensive Gastropathy.*The Medical Journal of Cairo University* Article 68, Volume 86, March, Winter 2018, Page 543–546.
17. DE LISI, S., PERALTA, S., ARINI, A., SIMONE, F. & CRAXÌ, A. 2011. Oesophagogastroduodenoscopy in patients with cirrhosis: Extending the range of detection beyond portal hypertension. Digestive and Liver Disease, 43, 48–53.
18. GJEORGJIEVSKI, M. & CAPPELL, M. S. 2016. Portal hypertensive gastropathy: A systematic review of the pathophysiology, clinical presentation, natural history and therapy. World journal of hepatology, 8, 231.
19. MANDHWANI, R., HANIF, F., HAQUE, M., WADHWA, R., LUCK, N.& MUBARAK, M.2017. Noninvasive clinical predictors of portal hypertensive gastropathy in patients with liver cirrhosis. Journal of translational internal medicine, 5, 169–173.
20. ELBARBARY, A., ELBEDEWY, M.& ELBADRY, A. 2014. Hemodynamic analysis of portal hypertension in patients with liver cirrhosis. Tanta Medical Journal, 42, 130.
21. KIM, M., CHOI, H., BAIK, S., YEA, C., WON, C., BYUN, J., PARK,S., KWON,Y., KIM, J. & KIM, H. 2010. Portal hypertensive gastropathy: correlation with portal hypertension and prognosis in cirrhosis. Digestive diseases and sciences, 55, 3561–3567.
22. EL SHARKAWY, E., FARIS, R., GRUMBACH, K., EDELMAN, R., CLEMENS, J., RAO, M. & DARWISH, M. 1997. Ultra sonographic measurements of the normal liver and spleen among Egyptians 10–50 years old. The Journal of the Egyptian Public Health Association, 72, 257–283.

Tables

Table (1). Comparison between endoscopic data by WLE and I-SCAN modes for fundic mucosa.

Fundic mosaic pattern		WLE		Test of sig.
		Absent n=27(%)	Present n=127(%)	
I-SCAN 1	Absent =20 (%)	14(51.9)	6(4.7)	χ^2=43.8
	Present =134(%)	13(48.1)	121(95.3)	p<0.001*
I-SCAN 2	Absent =20 (%)	14(51.9)	6(4.7)	χ^2=43.8
	Present =134(%)	13(48.1)	121(95.3)	p<0.001*
I-SCAN 3	Absent =23 (%)	14(51.9)	9(7.1)	χ^2=35.12
	Present =131(%)	13(48.1)	118(92.9)	p<0.001*
Fundic red spots		WLE		Test of sig.
		Absent n=27(%)	Present n=127(%)	
I-SCAN 1	Absent =102(%)	22(81.5)	80(63.0)	χ^2=3.4
	Present =52(%)	5(18.5)	47(37.0)	p=0.06
I-SCAN 2	Absent =56 (%)	17(63.0)	39(30.7)	χ^2=10.01
	Present =98(%)	10(37.0)	88(69.3)	p=0.002*
I-SCAN 3	Absent =42(%)	11(40.7)	31(24.4)	χ^2=2.99
	Present =112(%)	16(59.3)	96(75.6)	p=0.08

χ^2=Chi-Square test *statistically significant (p<0.05)

Table (2). Association of Mosaic Pattern and Red Spots by WLE with some clinical; laboratory and Ultrasonographic data.

Characteristics	WLE Mosaic Pattern		Test of sig.	WLE Red Spots		Test of sig.
	Absent	Present		Absent	Present	
Platelets Mean±SD	106.7±43.74	99.75±49.63	t=0.674 P=0.501	104.23±52.58	93.77±37.79	t=1.239 P=0.217
PV/mm Mean±SD	13.18±1.66	13.59±2.46	t=0.831 P=0.407	13.39±2.73	13.8±1.04	t=1.021 P=0.309
Spleen/cm Mean±SD	16.31±3.54	16.07±4.29	t=0.275 P=0.784	15.75±4.74	16.91±2.25	t=1.618 P=0.108
Child Pugh score Median (Range)	6 (5-9)	7 (5-11)	Z=2.506 P=0.012*	7 (5-11)	7 (5-11)	Z=0.344 P=0.731
APRI score Median (Range)	1.05 (0.38-2.82)	1.17 (0.3-26.57)	Z=2.2 P=0.026*	1.1 (0.3-26.57)	1.17 (0.43-7.22)	Z=1.569 P=0.117
Fib4 Median (Range)	4.08 (1.55-6.67)	3.51 (1.3-60.54)	Z=1.599 P=0.11	3.51 (1.3-60.54)	3.56 (1.55-13.34)	Z=0.624 P=0.532
MELD score Median (Range)	8 (3-22)	10 (3-25)	Z=0.401 P=0.688	10 (3-25)	9 (3-14)	Z=1.218 P=0.223

Table (3). Association of Mosaic Pattern and Red Spots by I-SCAN 1 with clinical; laboratory and Ultrasonographic data.

Characteristics	I-SCAN1 Mosaic Pattern		Test of sig.	I-SCAN1 Red Spots		Test of sig.
	Absent	Present		Absent	Present	
Platelets Mean±SD	108.6±49.77	99.82±48.48	t=0.752 P=0.453	103.14±53.9	96.71±36.02	t=0.775 P=0.439
PV/mm Mean±SD	13±1.86	13.6±2.4	t=1.077 P=0.283	13.41±2.79	13.75±0.96	t=0.846 P=0.399
Spleen/cm Mean±SD	17.07±3.86	15.97±4.19	t=1.107 P=0.27	15.71±4.83	16.9±2.16	t=1.691 P=0.093
Child Pugh score Median (Range)	6 (5-9)	7 (5-11)	Z=1.869 P=0.062	7 (5-11)	7 (5-9)	Z=0.784 P=0.433
APRI score Median (Range)	0.83 (0.3-2.5)	1.17 (0.33-26.57)	Z=2.008 P=0.045*	3.43 (1.3-60.54)	3.62 (1.55-13.34)	Z=0.703 P=0.482
Fib4 Median (Range)	2.5 (1.3-7.7)	3.56 (1.38-60.54)	Z=1.629 P=0.103	10 (3-25)	9 (3-14)	Z=1.793 P=0.073
MELD score Median (Range)	9 (4-22)	10 (3-25)	Z=1.033 P=0.302	7 (5-11)	7 (5-9)	Z=0.784 P=0.433

Table (4) Association of Mosaic Pattern and Red Spots by I-SCAN 2 with clinical; laboratory and Ultrasonographic data.

Characteristics	I-SCAN2 Mosaic Pattern		Test of sig.	I-SCAN2 Red Spots		Test of sig.
	Absent	Present		Absent	Present	
Platelets Mean±SD	108.6±49.77	99.82±48.48	t=0.752 P=0.453	101.04±41.81	100.93 ±52.26	t=0.013 P=0.99
PV/mm Mean±SD	13.0±1.86	13.6±2.4	t=1.077 P=0.283	13.69±1.71	13.42±2.63	t=0.681 P=0.497
Spleen/cm Mean±SD	17.07±3.86	15.97±4.19	t=1.107 P=0.27	17.24±3.37	15.47±4.43	t=2.586 P=0.011*
Child Pugh score Median (Range)	6 (5-9)	10 (3-25)	Z=1.869 P=0.62	7 (5-11)	7 (5-10)	Z=0.811 P=0.418
APRI score Median (Range)	0.83 (0.3-2.5)	1.17 (0.33-26.57)	Z=2.008 P=0.045*	1.09 (0.3-6.9)	1.17 (0.33-26.57)	Z=2.049 P=0.04*
Fib4 Median (Range)	2.5 (1.3-7.7)	3.56 (1.38-60.54)	Z=1.629 P=0.103	3.43 (1.3-15.78)	3.62 (1.38-60.54)	Z=0.789 P=0.43
MELD score Median (Range)	9 (4-22)	10 (3-25)	Z=1.033 P=0.302	10 (3-22)	10 (3-25)	Z=0.911 P=0.363

Table (5). Association of Mosaic Pattern and Red Spots by I-SCAN 3 with clinical; laboratory and Ultrasonographic data.

Characteristics	I-SCAN3 Mosaic Pattern		Test of sig.	I-SCAN3 Red Spots		Test of sig.
	Absent	Present		Absent	Present	
Platelets Mean±SD	102.91 ±56.53	97.46±46.41	t=2.16 P=0.032*	103.05±32.82	100.19 ±53.41	t=0.324 P=0.746
PV/mm Mean±SD	12.86±1.76	13.64±2.41	t=1.462 P=0.146	13.92±1.35	13.37±2.61	t=1.308 P=0.193
Spleen/cm Mean±SD	16.54±3.85	16.03±4.22	t=0.535 P=0.593	17.2±2.53	15.7±4.57	t=2.006 P=0.047*
Child Pugh score Median (Range)	6 (5-9)	7 (5-11)	Z=2.754 P=0.006*	7 (5-10)	7 (5-11)	Z=0.432 P=0.666
APRI score Median (Range)	0.58 (0.3-2.5)	1.17 (0.38-26.57)	Z=2.997 P=0.003*	0.85 (0.38-2.5)	1.19 (0.3-26.57)	Z=2.451 P=0.014*
Fib4 Median (Range)	1.85 (1.3-7.7)	3.62 (1.38-60.54)	Z=2.609 P=0.009*	3.3 (1.6-7.7)	3.66 (1.3-60.54)	Z=1.351 P=0.177
MELD score Median (Range)	9 (4-22)	10 (3-25)	Z=0.852 P=0.394	10 (3-15)	10 (3-25)	Z=0.871 P=0.384

Table (6) Validity and reliability of I-SCAN modes in detection of fundic PHG findings.

	Mosaic pattern			Red spots		
	I-SCAN 1	**I-SCAN 2**	**I-SCAN 3**	**I-SCAN 1**	**I-SCAN 2**	**I-SCAN 3**
Kappa agreement	0.525	0.525	0.475	0.882	0.411	0.290
Sensitivity (%)	95.3%	95.3%	92.9%	95.8%	100%	100%
Specificity (%)	51.9%	51.9%	51.9%	94.3%	52.8%	39.6%
PPV(%)	90.3%	90.3%	90.1%	88.5%	49%	42.9%
NPV(%)	70%	70%	60.9%	98%	100%	100%
Accuracy (%)	87.7%	87.7%	85.7%	94.8%	67.5%	58.4%

PPV: Positive predictive value. NPV: Negative predictive value.

Figures

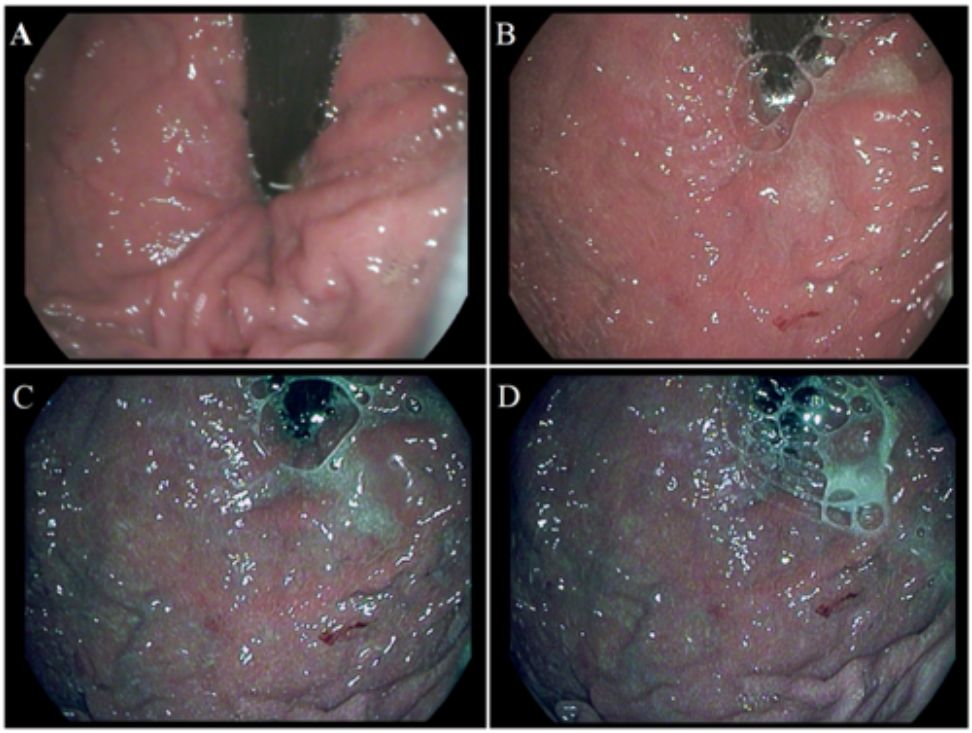

Figure 1

Endoscopic view of fundic mucosa in **patient number 10** **A:** WLE shows mild mosaic pattern and no red spots. **B:** I-SCAN 1 shows more dense reticulations of mosaic pattern and no red spots. **C:** I-SCAN 2 shows severe mosaic pattern and mild red spots. **D:** I-SCAN 3 shows severe mosaic pattern and mild red spots.

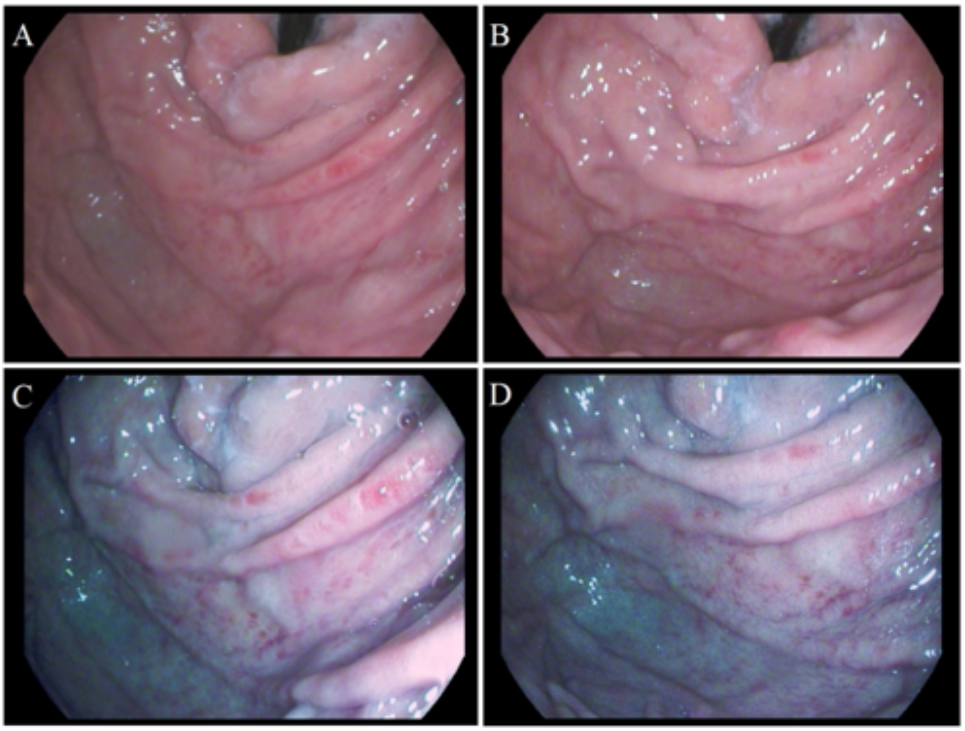

Figure 2

Red spots of PHG in **patient number 55.** **A:** WLE view of mild red spots in fundic mucosa. **B:** I-SCAN 1 shares almost the same picture of red spots shown by WLE. **C:** I-SCAN 2 shows more confluent red spots. **D:** I-SCAN 3 view of severe red spots.

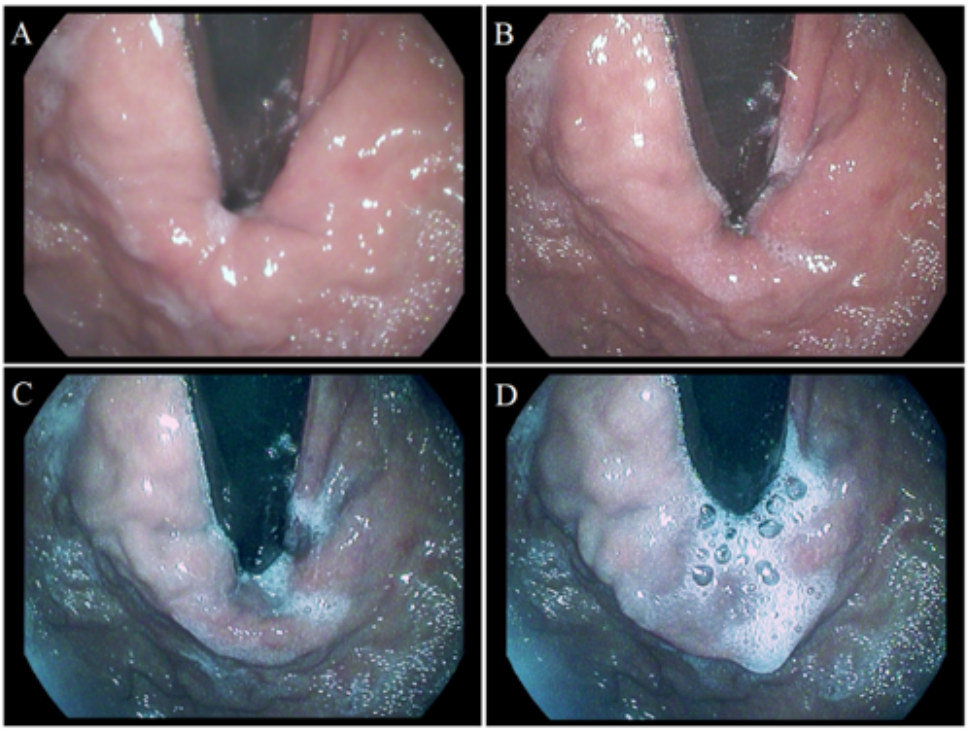

Figure 3

Mosaic pattern in **patient number 12**. **A:** WLE showing smooth mucosa without any mosaic pattern. **B:** I-SCAN 1 started to show reticulations in the mucosal surface described as mild mosaic pattern. **C:** More defined reticulations shown by I-SCAN 2 as mild mosaic pattern. **D:** I-SCAN 3 gives the same result as I-SCAN 2 and shows a reddish area as mild red spot.