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Roentgenologic Diagnosis of the Gastrointestinal
Tract by Harmonization

by

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Harmonization 法による消化管の X 線診断

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X線像の Harmonization による修整法は、写真技術的方法とTV法とがある。私達は今回Vidicon cameraの光電変換特性を利用したTV法による、Harmonizationを消化管診断に応用した。

消化管X線診断に対する Harmonization 法の応用には2つの方法がある。すなわち、

1. X線TV透視装置に Harmonization 装置を付設して、透視診断時におけるモニター像をハーモナイズする方法。

2. 撮影されたX線写真を、テレビX線写真読影装置を使用してハーモナイズする方法。とである。

消化管X線診断に対して、Harmonization 法の利点は次のごとくであつた。

1. 線状陰影が強調されるために、レリーフ像の詳細な観察に有利である。

2. 微細な陰影も強調されるため、微細病変を見逃すことが防止できる。

3. 消化管の輪郭が強調されるため、辺縁像の観察にすぐれている。

4. テレビ法による Harmonization 法は、1枚のX線写真のみでも Subtraction 効果もあり、骨陰影が薄くなり、骨陰影と重なる部分の観察に有利となる。

欠点としては

1. 蛍光増倍管のフリッカーも強調されるため、透視診断に際して、モニター面が多少見にくくなる。

2. 空泡が消化管内に残存していると、それも同時に強調されるため、モニター像またはX線写真の正確な読影ができなくなる。

3. 辺縁の強調により、隆起性所見が反対の陥凹性所見としてみられる。

以上のごとく、消化管X線診断に対する、Harmonization 法の応用には、2～3の欠点はあるが、それ以上に、透視診断時におけるモニター像および撮影されたX線写真より、より多くの診断情報を蒐集することができるようになった。

Harmonization for retouching of roentgenograms produces a shadow on the X-ray image and enhances the edge between the shadow and X-ray image (edge effect). There are two types in this method of retouching: photographic technique and video technique. Oldendorf (3, 4, 5) reported on the photographic technique and Zieler (11), Groh et al. (1) and Tanaka (8), on the video technique for which vidicon camera is used. More recently, Miller et al. (2) and Yamashita et al. (12) reported on the same subject. In the preceding paper (7), the authors reported that harmonization was excellent for the observation of thin and narrow peripheral vessels in the roentgenologic diagnosis of angiograms. Having learned that harmonization was excellent also for the observation of the relief pattern of the gastrointestinal tract since it enhances linear shadows, we have examined the roentgenologic diagnosis of the gastrointestinal tract in the present paper.

Method of Harmonization

The harmonization in the photographic technique is performed by enlarging the original film slightly to print on a film and laying this printed film and the original one upon the other for printing once more.

For the video method by the use of television camera, the property of photoelectric conversion of vidicon camera is applied and two sets of vidicon camera are required. The present report deals with the video method by the use of vidicon camera.

There are the following two methods for the application of harmonization to the roentgenologic diagnosis of the gastrointestinal tract.

- (1) To harmonize the monitor image of the apparatus for X-ray TV fluoroscopy.
- (2) To harmonize roentgenograms which have been taken.

For harmonization of the monitor image of the apparatus for X-ray TV fluoroscopy, another vidicon camera, an image amplifier and a video amplifier are required. Fig. 1 illustrates the apparatus which



Fig. 1. Harmonization apparatus and exclusive TV-monitor.

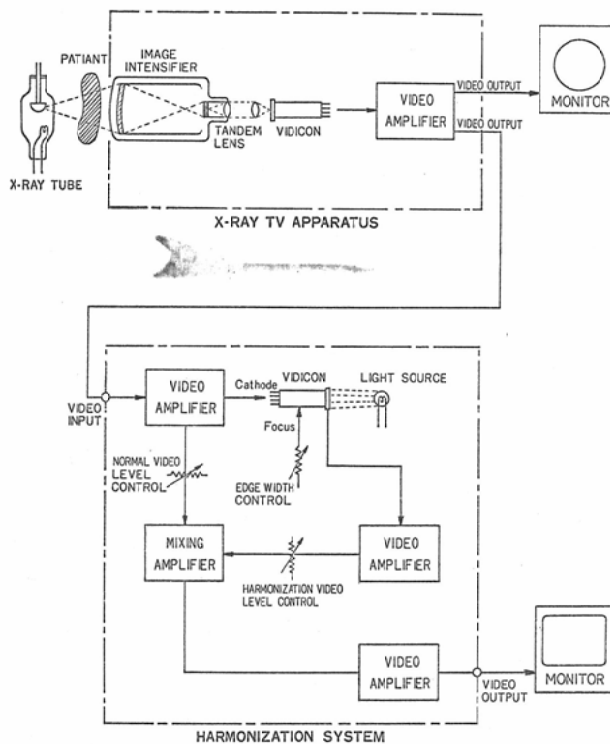


Fig. 2. Block diagram of harmonization system in X-ray TV. apparatus.

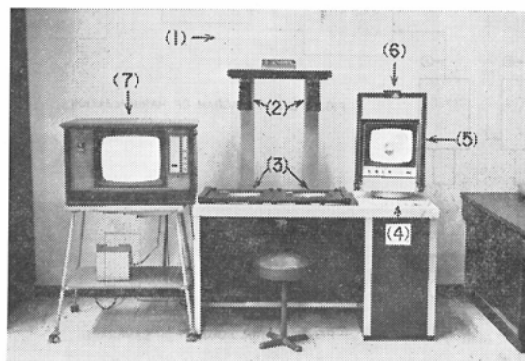


Fig. 3. Television X-ray film viewer.

- (1) TV. camera (Vidicon) (2) Zoom lens ($f=22.5-90.0$ mm. $F=1:1.5$)
 (3) Illuminating box (2 section) (4) Control panel (5) Monochrome
 TV monitor (6) Poraloid camera holder (7) Color TV monitor.

we have newly developed. Its block diagram is shown in Fig. 2.

For harmonization of X-ray film which have been taken, the TV X-ray film viewer shown in Fig. 3 is used. Fig. 4 illustrates its block diagram.

In the method of harmonization by the use of TV camera, one X-ray film is taken with camera (2), as shown in Fig. 5. This harmonization output is (a). When this (a) is sent to camera (1), photo-

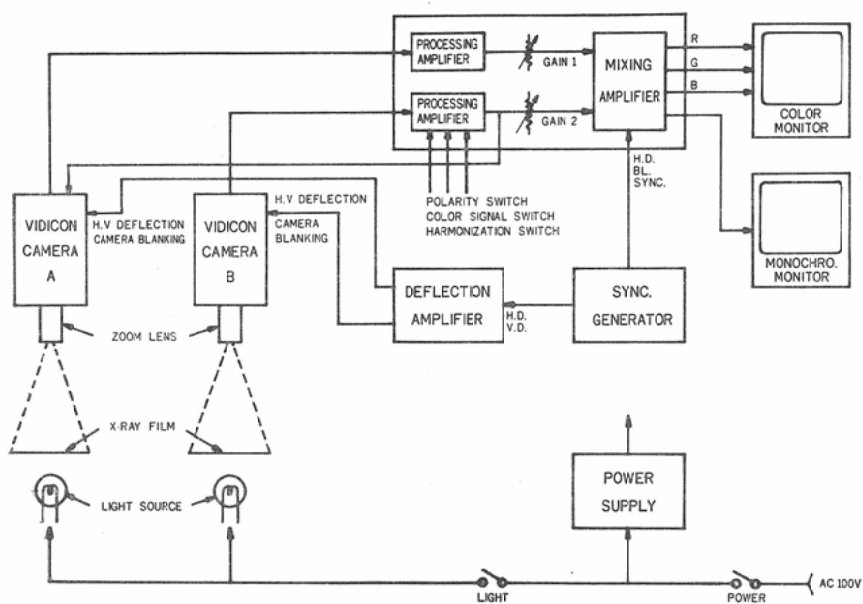


Fig. 4. Block diagram of TV X-ray film viewer.

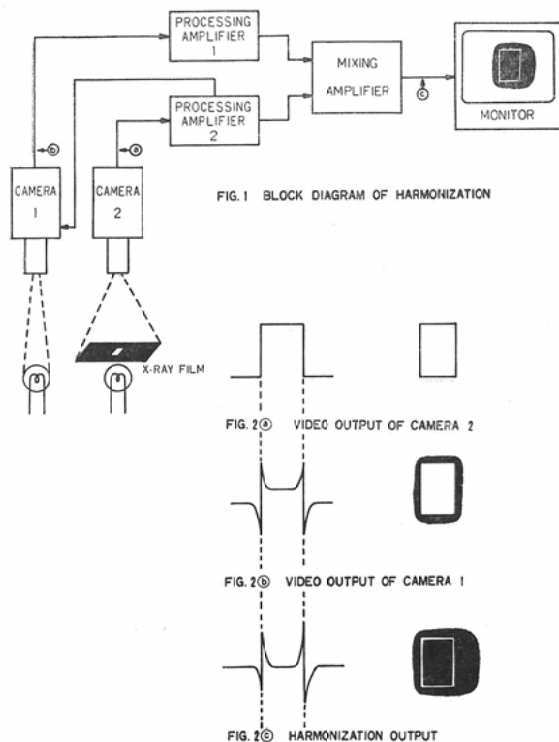
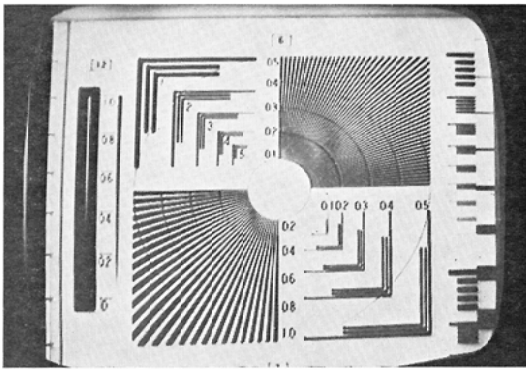
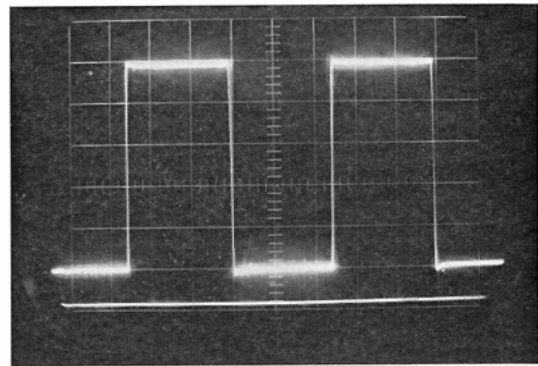


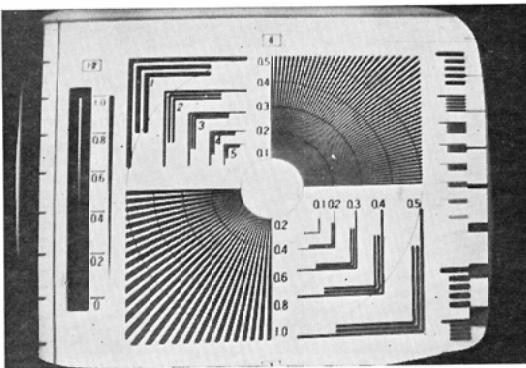
Fig. 5. Block diagram of harmonization and harmonization output.



(a)

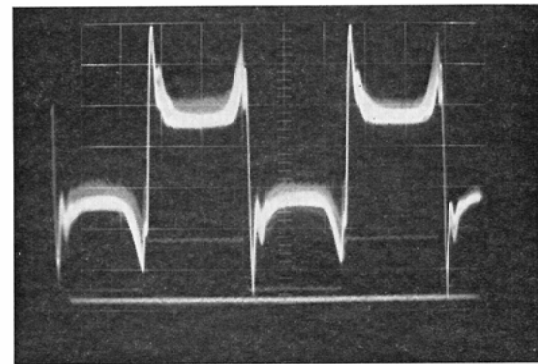


(a) Normal signal.

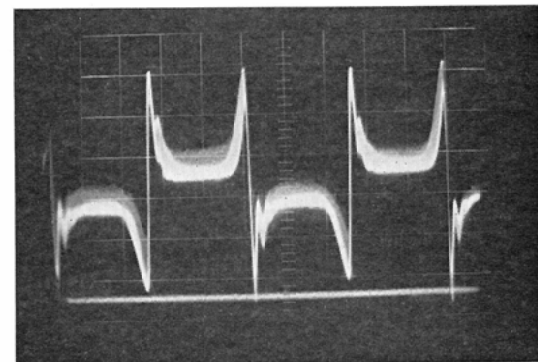


(b)

Fig. 6. Copies of test chart. Normal procedures (a) and harmonize image improvement (b).



(b) Harmonization signal of the apparatus for X-ray TV fluoroscopy (Harmonization signal plus normal signal).



(c) Harmonization signal of the apparatus for TV X-ray film viewer (Harmonization signal minus normal signal).

Fig. 7. Monitor picture (250 KHz square wave).

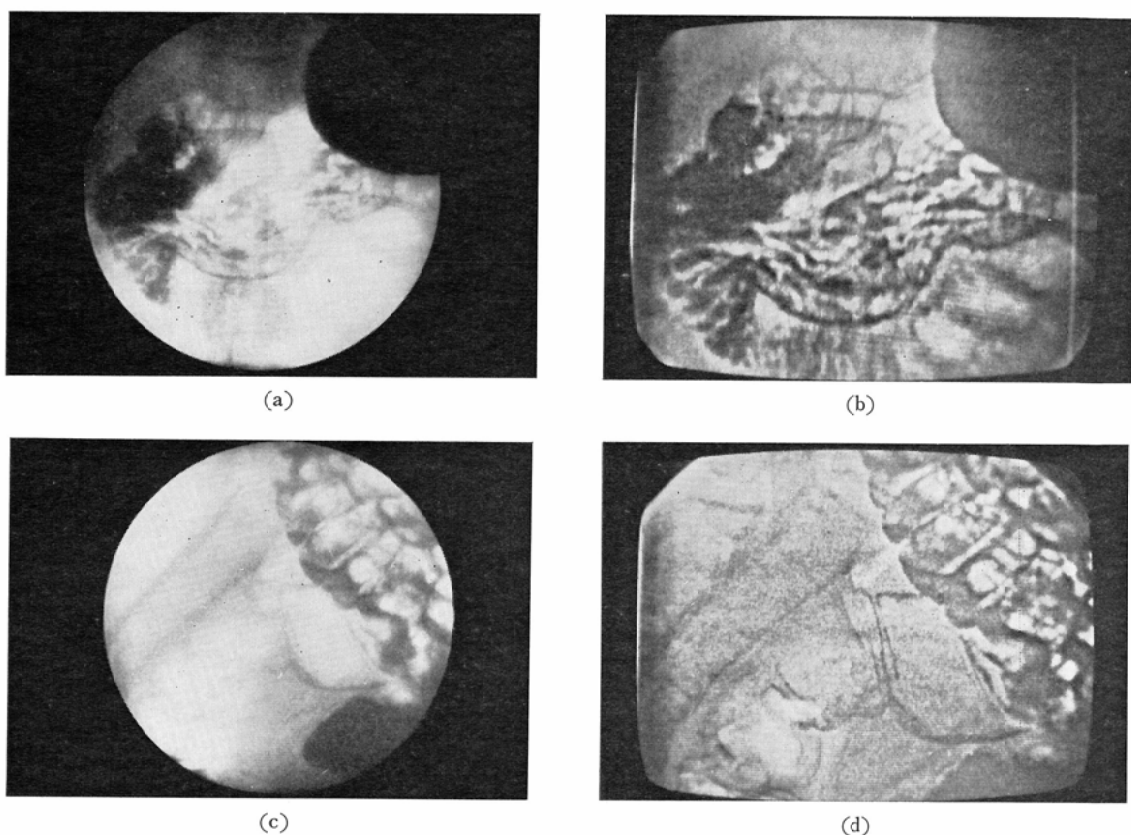


Fig. 8. Comparison of normal monitor image (a and c) and harmonize monitor image improvement (b and d).

electric conversion by camera (1) results.

Fig. 6 is the actual copy of a test chart. Fig. 7 presents the monitor picture. The monitor picture of the apparatus of harmonization attached to the apparatus for X-ray TV fluoroscopy is slightly different from that of TV X-ray film viewer.

Clinical Application

The present monitor image of the X-ray TV apparatus is not yet sufficient in the efficiency, i.e., the image quality and sharpness. In order to eliminate these weak points, we have devised a method for harmonization of the monitor.

Fig. 8 presents the comparison between the monitor image of the apparatus for X-ray TV fluoroscopy and that of the harmonization apparatus for fluoroscopy. (a) and (b) show the double contrast procedure of the normal stomach, and (c) and (d), the lateral picture of the rectum by a direct double contrast procedure of the colon. Comparison of these allows a clear observation of the contour of the stomach and the colon and the relief image of the mucous membrane.

The subsequent figures show harmonization of the roentgenograms which have been taken using TV X-ray film viewer.

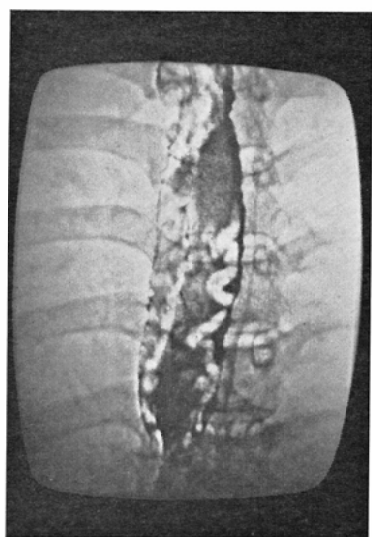


Fig. 9. Esophageal varices.

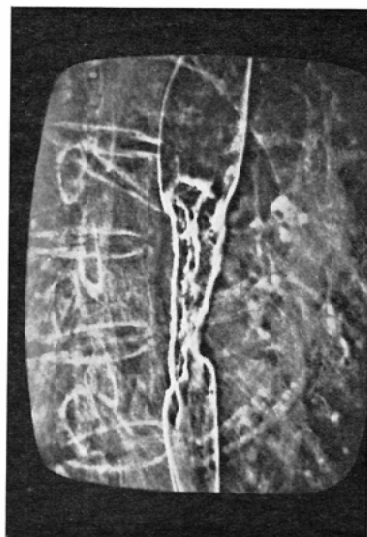


Fig. 10. Circular-stenotic type of esophageal carcinoma.



Fig. 11. Para-esophageal hiatus hernia with supradiaphragmatic cardiac ostium.

1. Harmonization of the Roentgenograms of the Esophagus.

For the roentgenologic diagnosis of the esophagus, the contour of the esophagus, the passage of barium and the relief image are the important findings. In addition, kymography and visualization of the vena azygos are the important supplementary diagnosis.

Fig. 9 shows the roentgenogram of the esophageal varices in a patient with liver cirrhosis and the dilated veins of the esophageal wall are clearly observed. Fig. 10 shows a case of circular-stenotic type of esophageal carcinoma. Fig. 11 presents a para-esophageal hiatus hernia which has extricated itself from the esophageal opening, and the windings redundant esophagus and the extricated fundal relief pattern are clearly observed.

2. Harmonization of the Roentgenograms of the Stomach.

In the roentgenologic diagnosis of the stomach, marginal niches, filling defects, the relief pattern and functional changes are the important findings. Particularly in recent years, morphological changes in the details of the relief pattern are regarded as important and for this reason, Buscopan and the double contrast procedure are actively adopted.

In Fig. 12 several egg-sharped radiolucent images and central indentation are observed in the anterior part of the pylorus. This case had erosive gastritis which has disappeared on the film taken 2 months later.

Fig. 13 demonstrates a case of peptic ulcer at the site of anastomosis after gastro-duodenostomy. The relief image of the remaining stomach can be observed clearly. Since the ulcer which has developed at the site of anastomosis was considerably large, accompanied by bleeding, reoperation was performed.

Fig. 14 (a) and (b) shows the image of mucosal convergence seen in peptic ulcer of the stomach, and (c), (d) shows that of gastric cancer. (c) indicates early gastric cancer depressed type (Type IIc)



Fig. 12. Erosions of the gastric mucosa in the pyloric portion.

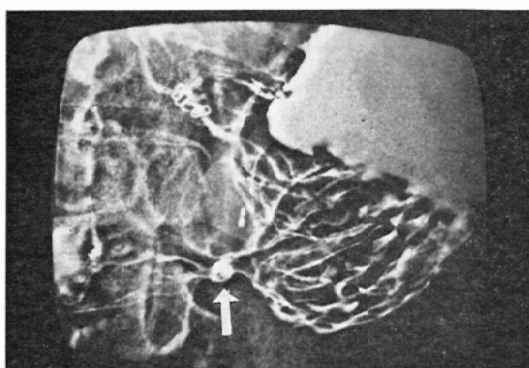
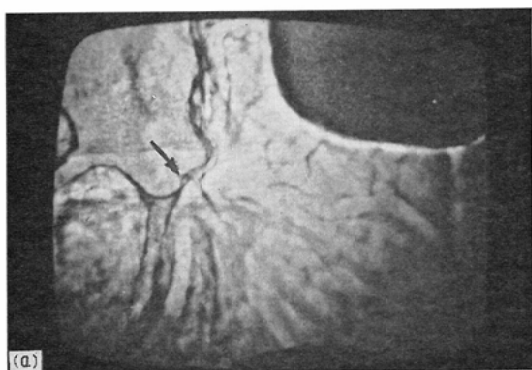
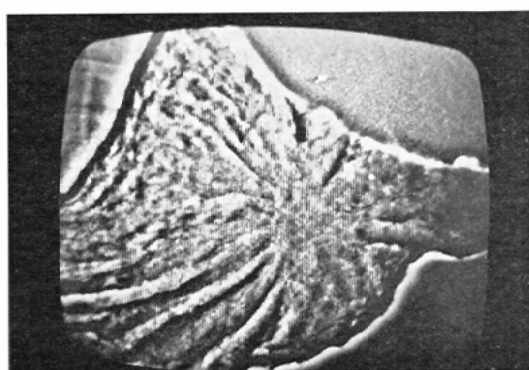


Fig. 13. Large marginal ulcer crater (arrow mark) after gastro-duodenostomy, directly at the site of the anastomosis.



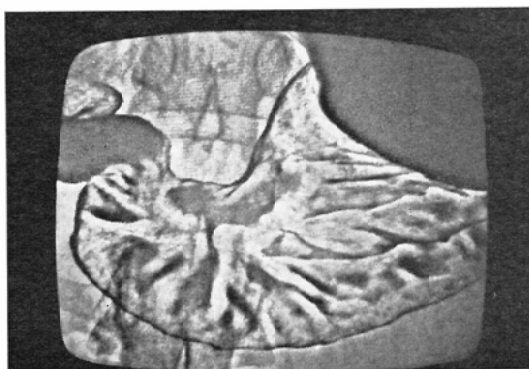
(a) Peptic ulcer.



(c) Early gastric cancer (depressed type).



(b) Peptic linear ulcer.



(d) Progressive gastric cancer (Borrmann II type).

Fig. 14. Comparison of mucosal convergence in peptic ulcer (a·b) and carcinoma (c·d) of the stomach.

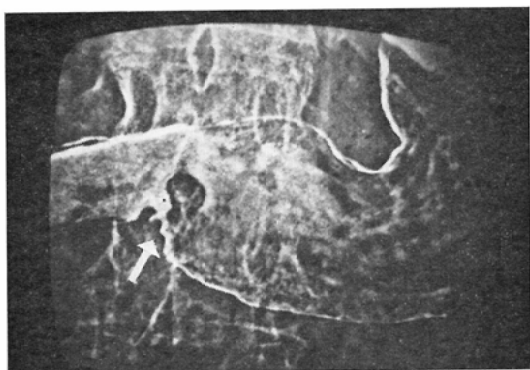


Fig. 15. Solitary pedunculated polyp (arrow mark).

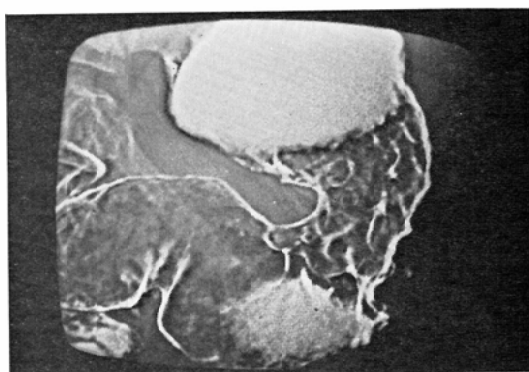
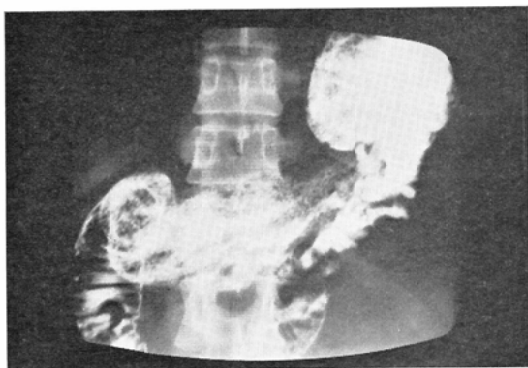
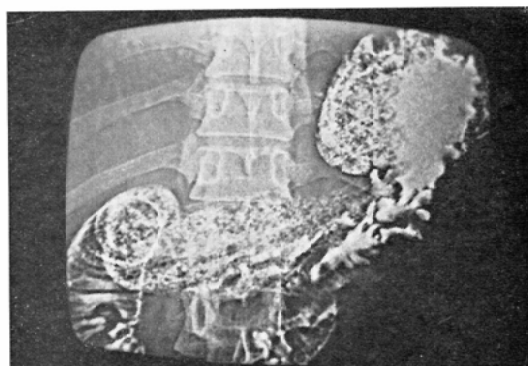


Fig. 16. Giant rugae (scirrhous adenocarcinoma).



(a)



(b)

Fig. 17. Comparison of normal image (a) and harmonize image improvement (b) of leavings bubble in the stomach.

and (d) indicates progressive one (Bormann II type). The image of mucosal convergence of benign ulcer has regularity in converging folds and a pointed end of folds seldom thickens clavately or fuses compared with that of malignant ulcer. However, it is sometimes difficult to distinguish benignity from malignancy by the image of mucosal convergence, and we often have to wait results of cytological diagnosis. Harmonization method demonstrates a fine shadow and is effective for observation of state of the end part of converged mucosal folds and of degree of progress of the lower part of ulcer or ulcer itself.

Fig. 15 shows a solitary pedunculated polyp which has developed from the greater curvature of the pyloric vestibule. Since such a protruding lesion enhances the shadow of barium which is attached to the margin of the polyp, the central part appears to be just like an indented change.

Fig. 16 illustrates scirrhous adenocarcinoma in which giant rugae were observed. In this case also, protrusion is observed as an indented change.

Fig. 17 is a roentgenogram of a normal stomach, but since it was taken immediately after the administration of 3 g. of a vesicant, numerous bubbles remain. (a) is the normal image and (b) is a harmonized one. It is noted that bubbles are more enhanced in (b). These bubbles of the vesicant disappear at 3–4 minutes later. Such an enhancement of the bubbles is a disadvantage of harmonization.

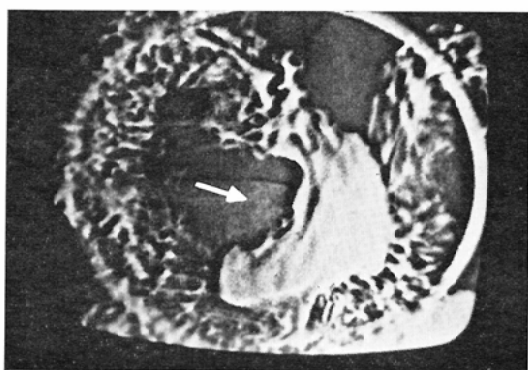


Fig. 18. Non-epithelial benign tumor in the duodenal bulb.

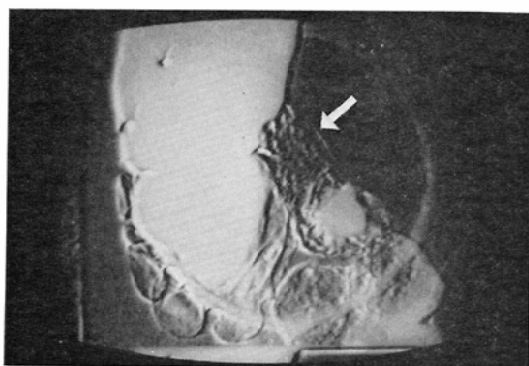


Fig. 19. Non sclerosing ileitis, hyperplasia of the lymphfollicles in the terminal ileum.

3. Harmonization of the Roentgenograms of the Small Intestine.

In the roentgenologic diagnosis of the small intestine from the duodenal bulb to the terminal ileum, the movement, constriction or dilatation of the intestinal tract, and Kerkring's folds are the important points for observation, and the filling defect due to tumor is rare. Ulcer crater is sometimes observed in the duodenal bulb but such a duodenal ulcer is relatively infrequent and deformation of the bulb frequently becomes an important finding. It is expected in the future to obtain the diagnostic information on the minute pathological changes of the lymphatic follicle by the double contrast procedure, similarly to the roentgenologic diagnosis of the stomach.

Fig. 18 shows a non-epithelial benign tumor which has developed from the greater curvature side of the duodenal bulb and filling defects are observed in the duodenal bulb.

Fig. 19 presents a case of a girl who came to the hospital with the chief complaint of ileocecal pain. As noted in the figure, the terminal ileum extending over approximately 10 cm. from the ileocecal valve is observed as granules, showing that this is hyperplasia of the lymph follicle. This lymph follicle is actually protruding but appears to be indented, similarly to the stomach polyp.

4. Harmonization of the Roentgenograms of the Colon.

The roentgenologic diagnosis of the colon is made by oral procedure or barium enema method. Recently, for the latter, direct double contrast procedure by Welin (9, 10) has been solely performed. The formation and contour of the haustra and the relief pattern are the important findings. In addition, shortening, narrowing or dilatation of the intestinal tract are the important items for observation.

Fig. 20 is an X-ray film of the ileocecal region by a direct double contrast procedure. Observed is the marginal protrusion (arrow mark) due to the shortening of the protruding valve of Bauhin.

Fig. 21 shows a case of tuberculosis of the colon which was complicated during the course of pulmonary tuberculosis. An ulcer crater is observed and irregularity of the ileocecal folds is well observed also.

Fig. 22 demonstrates ulcerative colitis after the lapse of 9 months after the onset and innumerable pseudopolyposis have developed from the sigmoid colon to the ascending colon. By the oral administration of Predonisolone, the clinical symptoms such as diarrhea and abdominal pain have disappeared.



Fig. 20. Protruding valve of Bauhin (This is a normal finding observed on contraction of the valve).

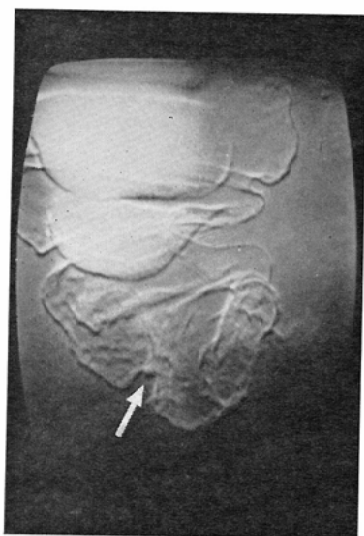


Fig. 21. Ulcer crater (arrow mark) of the cecal region due to tuberculosis of colon.

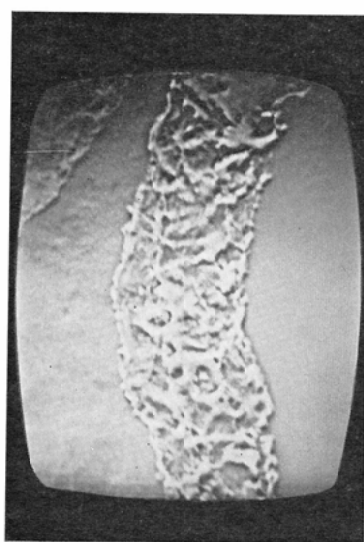


Fig. 22. Ulcerative colitis with pseudopolypsis.

Fig. 23 presents a case in which there was a relapse after the operation of gastric cancer, leading to carcinomatous infiltration in the wall of the colon. In comparison with the normal image, the harmonized one is more excellent for the observation of the relief pattern.

Conclusion

There are two methods in the application of harmonization to the roentgenologic diagnosis of the gastrointestinal tract.

1. The apparatus for harmonization is attached to the apparatus for X-ray TV fluoroscopy to harmonize the monitor image at the time of fluoroscopic diagnosis.
2. Roentgenograms which have been taken are harmonized by the use of TV X-ray film viewer.

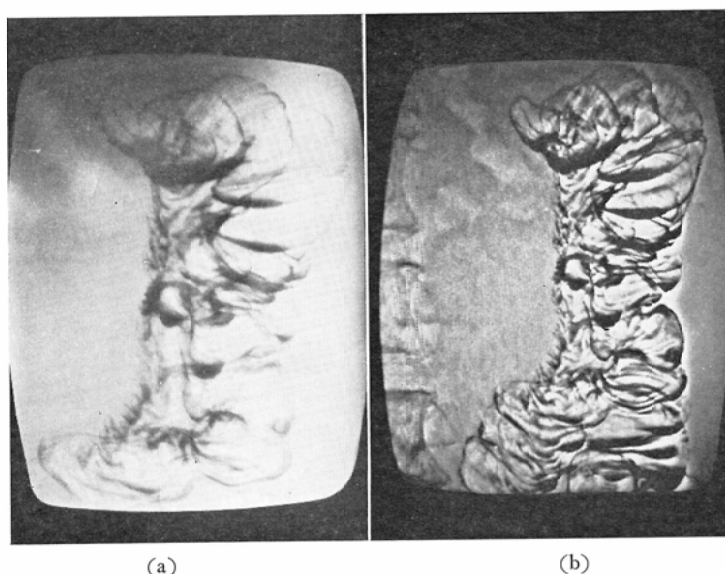


Fig. 23. Comparison of normal procedure (a) and harmonized image improvement (b) (infiltrative colon carcinoma with gastric carcinoma).

The advantages of harmonization for the roentgenologic diagnosis of the gastrointestinal tract are as follows:

1. Since linear shadows are enhanced, it is advantageous for detailed observations of the relief image.
2. Since minute shadows are enhanced, minute lesions are infrequently overlooked.
3. Since the contour of the gastrointestinal tract is enhanced, it is excellent for the observation of the marginal image.
4. The harmonization by the video method is advantageous for the observation of the part overlapping the bone shadow since there is an effect of subtraction only by one roentgenogram, making bone shadows thin.

The above 1, 2 and 3 are due to the so-called effect of edge and 4 to that effect of auto-subtraction.

The following disadvantages are noted also in harmonization.

1. Since the flicker of the image amplifier is enhanced also, the monitor surface becomes slightly invisible at the time of fluoroscopic diagnosis.
2. When vacuoles remain, they are simultaneously enhanced also, interfering with reading of the monitor image or roentgenograms.
3. Due to the enhancement of the margins, protruding findings are sometimes observed contrarily as indented ones.

Among these disadvantages, the problem of the enhancement of vacuoles in 2 is settled if vacuoles are not left, but 1, 2 and 3 will not be solved.

The image quality of monochrome monitor is 600 horizontally and 400 vertically.

Summary

Harmonization was applied to the roentgenologic diagnosis of the gastrointestinal tract. Since

harmonization enhances minute pathological changes in the relief image and contour of the gastrointestinal tract, accurate diagnostic information can be collected in a larger amount.

However, enhancement of the flicker of the image amplifier is unavoidable and it must be taken into consideration that protruding findings are observed as indented ones.

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