Observational Study

Autofluorescence imaging endoscopy can distinguish non-erosive reflux disease from functional heartburn: A pilot study

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AIM: To investigate whether autofluorescence imaging (AFI) endoscopy can distinguish non-erosive reflux disease (NERD) from functional heartburn (FH).

METHODS: In this prospective observational trial, 127 patients presenting with typical reflux symptoms for > 6 mo were screened. All the participants underwent endoscopy, during which white light imaging (WLI) was performed by AFI. Finally, 84 patients with normal esophageal appearance on WLI were enrolled. It was defined as being suggestive of NERD if one or more longitudinal purple lines longer than one centimeter were visualized in the distal part of the esophagus during AFI endoscopy. Ambulatory 24-h multichannel intraluminal impedance and pH monitoring was also performed. After standard proton-pump inhibitor (PPI) tests, subjects were divided into a NERD group and a FH group and the diagnostic performance of AFI endoscopy to differentiate NERD from FH was evaluated.

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To date, few efforts have been put on endoscopy. These common manifestations make it absence of esophageal abnormalities on conventional including the presence of reflux symptoms and the Functional heartburn (FH) and non-erosive reflux disease from functional heartburn: A pilot study. Autofluorescence imaging endoscopy can distinguish non-erosive reflux disease from functional heartburn (FH). Its real-time characteristics are useful in predicting acid reflux, whereas FH is not. Whether AFI endoscopy is capable of differentiating NERD from FH has not yet been determined. This study aimed to investigate the diagnostic performance of AFI video endoscopy to distinguish NERD from FH in patients with typical reflux symptoms but no mucosal breaks in the esophagus on WLI.

CONCLUSION: Autofluorescence imaging may serve as a complementary method in evaluating patients with NERD and FH.

Key words: Gastroesophageal reflux disease; White light imaging; Non-erosive reflux disease; Functional heartburn; Autofluorescence imaging; Ambulatory 24-h pH/impedance monitoring; Endoscopy; Esophagitis

Core tip: To date, few efforts have been put on the application of autofluorescence imaging (AFI) endoscopy in patients with non-malignant conditions such as gastrointestinal reflux disease (GERD). Our data showed that endoscopic features on AFI can distinguish non-erosive reflux disease (NERD) from functional heartburn (FH). Its real-time characteristics and simple endoscopic criteria may enhance the use of AFI as a complementary tool in the differentiation of NERD and FH. We believe that these findings have important implications for future research on the application of AFI endoscopy in patients with GERD.

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INTRODUCTION

Functional heartburn (FH) and non-erosive reflux disease (NERD) share common manifestations, including the presence of reflux symptoms and the absence of esophageal abnormalities on conventional endoscopy. These common manifestations make it difficult to distinguish between FH and NERD without invasive diagnostic tests[1,2]. Autofluorescence imaging (AFI) is capable of identifying indistinct mucosal lesions[3,4] invisible on conventional endoscopy. Trichoscopy and NERD, whereas FH is not. Whether AFI endoscopy is capable of differentiating NERD from FH has not yet been determined. This study aimed to investigate the diagnostic performance of AFI video endoscopy to distinguish NERD from FH in patients with typical reflux symptoms but no mucosal breaks in the esophagus on WLI.

MATERIALS AND METHODS

Study subjects

The study protocol was approved by the Ethics Committee of Chinese PLA General Hospital and conformed to the principles of the Declaration of Helsinki. This trial has been registered at ClinicalTrials.gov (ID: NCT01504971). Written informed consent was obtained before each participant was enrolled.

In this prospective observational trial, consecutive patients with typical heartburn and/or regurgitation for > 6 mo were screened in Chinese PLA General Hospital between 2012 and 2014 (Figure 1). All patients underwent gastroscopy with both WLI and AFI functioning. Ambulatory impedance and pH monitoring was also performed. All participants were subsequently assessed by standard proton-pump inhibitor (PPI) tests. Patients with any symptom suggestive of esophageal motility disorders other than gastroesophageal reflux disease (GERD) were assessed by esophageal manometry.

Patients aged 18-75 years and with negative esophageal findings on WLI were eligible for this study. Patients would not be included if they had any known esophageal disease, including esophagitis or Barrett’s esophagus; gastric or duodenal ulcer (except scarring); a previous history of thoracic or upper gastrointestinal (GI) surgery; clinically significant heart, lung, liver, or kidney disease; or pregnancy.

Esophagogastroduodenoscopy

Before endoscopic examination, antisecretory therapy, including PPIs and histamine-2 receptor antagonists, was discontinued for no less than 1 mo. Oral antacid was allowed as rescue medication during wash-out period. Gastroscopy was performed using a FQ260Z endoscope (Olympus Inc., Tokyo, Japan), equipped with multiple charged coupled devices for both high-definition WLI and AFI. During endoscopic examination, the upper GI tract was carefully visualized using WLI, with the presence of a normal or abnormal esophagus

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documented. The video endoscope was subsequently switched to AFI mode and the esophagus again examined. It was defined as being suggestive of NERD if one or more longitudinal purple lines longer than one centimeter were visualized in the distal part of the esophagus during AFI endoscopy.

Ambulatory pH and impedance monitoring
Ambulatory 24-h multichannel intraluminal impedance and pH monitoring was performed using the routine protocol of our department. Briefly, a catheter (Sierra Scientific Instruments Inc., Los Angeles, CA, United States) was inserted transnasally and the pH sensor was sited 5 cm above the lower esophageal sphincter (LES) with the impedance recording segments positioned at 3, 5, 7, 9, 15 and 17 cm above the upper border of the LES. The catheter was connected to a data storage device programmed by an AccuTrac pH-Z System (Sierra Scientific Instruments Inc, Los Angeles, CA, United States). Patients were asked to record a diary of their symptoms and activity, including the time of rising in the morning, times in the supine position and meal times, as well as the onset of symptoms. AccuView analysis software (Sierra Scientific Instruments Inc, Los Angeles, CA, United States) was used to identify acid and non-acid episodes. Symptom association probability (SAP) and symptom index (SI) were assessed to determine the relationship of symptoms with acid, weakly acid or weakly alkaline reflux during monitoring. A positive pH/impedance test was defined as (1) acid exposure time more than 4.2% of monitoring time; (2) SAP $\geq 95$%; or (3) SI $>50\%$.[6,7].

Diagnosis of NERD and FH
A diagnosis of NERD was reached when the endoscopy-negative patients presented a positive pH/impedance or PPI test.[8,9]. Consistent with Rome III criteria,[8] patients with normal esophageal findings on WLI were diagnosed with FH if they had normal pH/impedance monitoring results and negative PPI tests.

Statistical analysis
Data are expressed as mean ± standard deviation. The subjects were divided into an NERD group and an FH group. The diagnostic performance of AFI for differentiating NERD from FH was calculated, using the sensitivity, specificity, accuracy, positive predictive value and negative predictive value with 95%CI. SPSS software (SPSS version 11.5, Chicago, IL, United States) was applied for statistical analyses. The diagnostic performance of different measures was evaluated using the McNemar test.

RESULTS

Demographic features
Of the 127 consecutive patients with typical reflux symptoms screened for this study, 43 were excluded due to a previous history of upper gastrointestinal surgery, chronic liver or renal disease, refusal to pH-metry. Finally, 84 patients with negative esophageal findings on WLI were enrolled; their demographic and clinical characteristics are shown in Table 1.

Yield of pH/impedance monitoring and PPI test
Of 84 eligible participants, 48 (57.1%) were positive on pH/impedance tests (Figure 2), suggesting a diagnosis of NERD. Of 36 patients (42.9%) with normal pH/impedance results, 26 benefitted from PPI tests and were classified as having NERD and the remaining 10 patients were classified as having FH.

Diagnostic value of AFI endoscopy
Altogether, 68 (81.0%) of the 84 patients were positive on AFI endoscopy (Figure 3) and the others were negative (Figure 4). Of 74 patients diagnosed with NERD, 67 had abnormal AFI findings (Table 2), giving this test a sensitivity of 90.5% (95%CI:}
In the present study, patients with typical reflux symptoms were investigated using AFI endoscopy as well as 24-h pH and impedance tests. Our results showed that AFI was able to identify differences in endoscopic features between NERD and FH. Thus, AFI endoscopy may have potential in distinguishing between these two diseases.

AFI, which was incorporated into a Tri-modal Imaging Endoscope system, has been increasingly used in the assessment of Barrett’s esophagus[10-12] and the appearance of purple areas on a green background indicates the neoplastic changes that occur in Barrett’s esophagus. Changes in coloration of the gastrointestinal tract revealed by AFI, however, do not represent 81.5%-96.1%) and a specificity of 90.0% (95%CI: 55.5%-99.7%). Meanwhile, the accuracy, positive predictive value and negative predictive value of AFI in differentiating between NERD and FH were 90.5% (95%CI: 84.2%-96.8%), 98.5% (95%CI: 92.1%-99.9%) and 56.3% (95%CI: 30.0%-80.2%), respectively.

| AFI          | NERD  | FH   | Total |
|--------------|-------|------|-------|
| Positive     | 67    | 1    | 68    |
| Negative     | 7     | 9    | 16    |
| Total        | 74    | 10   | 84    |

McNemar test, \( P = 0.07 \). AFI: Autofluorescence imaging; NERD: Non-erosive reflux disease; FH: Functional heartburn.

**DISCUSSION**

In the present study, patients with typical reflux symptoms were investigated using AFI endoscopy as well as 24-h pH and impedance tests. Our results showed that AFI was able to identify differences in endoscopic features between NERD and FH. Thus, AFI endoscopy may have potential in distinguishing between these two diseases.

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one type of neoplasia-specific manifestations, as AFI
cannot identify the direct features of gastrointestinal
neoplasms, such as loss of micro-architecture regularity
and/or disruption of normal capillary patterns in the
superficial layer of lesions. It was found that changes
in tissue components, regardless of whether they
are caused by neoplasia or inflammation, alter the
density of autofluorescence emitted from lesions[13-15].
These findings suggest that AFI may also be useful to
evaluate diseases caused by inflammation, such as
esophagitis[5].

Differentiating NERD from FH remains challen-
ging[19], as both disorders share similar clinical mani-
festations, such as reflux symptoms and normal
esophageal appearance on traditional endoscopy.
The responsiveness to PPI tests is diagnostic of GERD
and excludes the possibility of FH, but the converse
is not necessarily true because the response rate of
NERD to PPI therapy was reported to be low, around
37%-73%[16-18]. These findings indicate that more than
one quarter of patients with NERD are refractory to
PPIs, making it difficult to distinguish between NERD
and FH. Routine methods of evaluating patients with
persistent reflux symptoms after PPI tests include
esophagogastroduodenoscopy and esophageal pH
monitoring. Various new techniques have been
introduced, including esophageal histopathological
analysis and esophageal impedance monitoring, in
order to improve the clinical management of patients
suspicous for NERD and FH. This study describes a new
method using AFI to differentiate between NERD and
FH. The presence of purple lines in the distal esophagus
on AFI, which are indistinct on standard endoscopy,
is considered diagnostic of GERD, including erosive
esophagitis and NERD. Moreover, the endoscopic
features identified by AFI were found to correlate with
pathologic reflux[5]. GERD is characteristic of reflux from
the stomach to the esophagus, but no reflux underlies
FH. Therefore positive findings on AFI may help
distinguish NERD from FH.

Our results showed the diagnostic value of AFI in
distinguishing between NERD and FH was promising,
with a sensitivity of 90.5% and a specificity of 90%.
These findings were comparable to results obtained with
other new diagnostic modalities, such as identification
of microscopic esophagitis and analysis of esophageal
baseline impedance[19,26]. Microscopic esophagitis, which is considered a histological marker of both erosive
esophagitis and NERD[21,22], can be observed in the
distal esophagus of almost all patients with erosive
esophagitis and in 70%-76% of those with NERD[21,23].
Recently, it was reported that histological evaluation of
biopsy specimens from the distal esophagus of patients
with reflux symptoms to show the presence or absence
of microscopic esophagitis was capable of differentiating
NERD from FH, with a sensitivity of 74% and an
accuracy of 79%[19]. Also, change in baseline impedance
was found to be a marker of pathological reflux, which
can distinguish NERD from FH with a sensitivity of 78%
and a specificity of 71%[20]. In addition, prolonged
wireless esophageal pH monitoring was found to have a
higher sensitivity in identifying NERD than 24-h pH
monitoring. Nearly one-third of patients who fulfilled the
Rome III criteria for FH were found to have NERD after
esophageal pH monitoring for > 48 h[24].

Although symptom-based approaches are favored in
the initial diagnosis of GERD, endoscopic examination is
always recommended for patients who do not respond
to PPI tests, and patients suspicious for Barrett’s eso-
phagus[6,25]. AFI may improve the diagnostic yield of
dysplasia or early stage malignancy in the esophagus.
Recent studies showed both second and third generation
AFI systems were more effective than first generation
systems in detecting early neoplastic lesions[26-29].
Our findings suggest that, in addition to neoplastic disease,
AFI may also be helpful in the diagnosis of NERD. Its
advantages, including real-time evaluation and simple
diagnostic criteria, imply that AFI may serve as a
complementary method in differentiating NERD from
FH. As stated above, other new diagnostic methods,
such as prolonged wireless esophageal pH monitoring[24]
and identification of microscopic esophagitis[22], may
also be useful in distinguishing between NERD and
FH. However, esophageal impedance and wireless pH
monitoring cannot be performed simultaneously[24],
reducing the ability to diagnose non-acid reflux[30]. In
addition, microscopic esophagitis has shown limitations
in identifying NERD, as nearly 20% of patients with
NERD showed no evidence of microscopic esophagitis[27].
As none of the above diagnostic modalities is perfect,
how to choose these methods is needed to be optimized
for patients with suspicion of NERD or FH.

One limitation of this study is the lack of esophageal
biopsies. Microscopic esophagitis in the distal esophagus
due to reflux may change tissue components, such as
collagen and other fluorescent substances[31],
attenuating AFI. However, we had no histopathological
evidence to support this hypothesis, suggesting the
need for further studies combining endoscopic and
histopathological methods. Another limitation was that
repeated AFI was not performed after PPI treatment in
patients positive on AFI. It is unclear whether standard
PPI treatment reverses abnormal findings on AFI.
Previous data showed that treatment with omeprazole
for 6 mo completely restored dilated intercellular
spaces[32], which are considered characteristic of micro-
scop scopic esophagitis in NERD[22]. It implied that positive
AFI findings are likely to diminish after PPI therapy.
Further studies are needed to clarify the duration of PPI
treatment required to reverse positive AFI findings.

In summary, this prospective observational
study showed that endoscopic features on AFI can
distinguish NERD from FH. Its real-time characteristics
and simple endoscopic criteria may enhance the use
of AFI as a complementary tool in the differentiation
of NERD and FH.
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COMMENTS

Background
It is difficult to differentiate between functional heartburn (FH) and non-erosive reflux disease (NERD) endoscopically. Autofluorescence imaging (AFI) was recently shown to reveal indistinct mucosal lesions invisible on conventional endoscopy. Moreover, endoscopy with AFI was shown to predict acid reflux in patients with gastroesophageal reflux disease (GERD). NERD is characterized endoscopically by the presence of pathologic reflux, while FH is not. This study aimed to assess whether AFI endoscopy could distinguish NERD from FH.

Research frontiers
Reflux symptoms are common in the general population. GERD (including NERD and FH) may underlie these symptoms. In order to differentiate NERD from FH, esophageal impedance monitoring, esophageal pH monitoring and proton pump inhibitor (PPI) test are often needed. Presently, various new techniques have been introduced, including esophageal histopathological analysis and esophageal impedance monitoring, in order to improve the clinical management of patients suspicious for NERD and FH.

Innovations and breakthroughs
To date, few efforts have been put on the application of AFI endoscopy in patients with GERD. In this pilot study, the authors found that endoscopic features on AFI can distinguish NERD from FH.

Applications
This study suggested that AFI may serve as a complementary tool in the clinical management of patients with reflux symptoms.

Terminology
AFI is a kind of digital imaging technique that detects autofluorescence that is emitted in response to light by endogenous fluorophores and cannot be observed by conventional endoscopy. NERD is a distinct pattern of GERD. It is caused by the reflux of gastric contents into the esophagus, but no mucosal damage is found at conventional endoscopy. FH is defined as retrosternal burning in the absence of GERD or other factors that can be detected in an objective manner.

Peer-review
The authors did an excellent job of assessing AFI endoscopy for its utility in the evaluation of NERD vs FH. The flow diagram explaining patient recruitment and exclusions is extremely helpful and the color images are exceptionally well done, and very instructive.

REFERENCES
1 Savarino E, Zentilin P, Savarino V. NERD: an umbrella term including heterogeneous subpopulations. Nat Rev Gastroenterol Hepatol 2013; 10: 371-380 [PMID: 23528345 DOI: 10.1038/ nrgastro.2013.50]
2 Savarino E, Marabotto E, Zentilin P, Frazzoni M, Sammito G, Bonfanti D, Sconfienza L, Assandri L, Gemignani L, Malesci A, Savarino V. The added value of impedance-pH monitoring to Rome III criteria in distinguishing functional heartburn from non-erosive reflux disease. Dig Liver Dis 2011; 43: 542-547 [PMID: 21376679 DOI: 10.1016/j.dld.2011.01.016]
3 Song LM, Banerjee S, Desilets D, Dhillon DL, Farraye FA, Kaul V, Kethu SR, Kwon R5, Mamula P, Pedrosa MC, Rodriguez SA, Tierney WM. Autofluorescence imaging. Gastrointest Endosc 2011; 73: 647-650 [PMID: 21296434 DOI: 10.1016/j.gie.2010.11.006]
4 Uedo N, Ishii H, Tatsuta M, Yamada T, Oyama H, Imanaka K, Sugimoto N, Higashino K, Ishihara R, Narahara H, Ishiguro S. A novel videendoscopy system by using autofluorescence and reflectance imaging for diagnosis of esophagogastric cancers. Gastrointest Endosc 2005; 62: 521-528 [PMID: 16185965 DOI: 10.1016/j.gie.2005.06.031]
5 Wang W, Uedo N, Yang Y, Peng L, Bai D, Lu Z, Fan K, Wang J, Wang X, Zhao Y, Yu Z. Autofluorescence imaging endoscopy for predicting acid reflux in patients with gastroesophageal reflux disease. J Gastroenterol Hepatol 2014; 29: 1442-1448 [PMID: 25587615 DOI: 10.1111/j.1440-7683.2014.06193.x]
6 Weusten BL, Roelofs JM, Akkermans LM, Van Berge-Henegouwen GP, Smout AJ. The symptom-association probability: an improved method for symptom analysis of 24-hour esophageal pH data. Gastroenterology 1994; 107: 1741-1745 [PMID: 7958686]
7 Savarino E, Tutuian R, Zentilin P, Dalbecko P, Pohl D, Marabotto E, Parodi A, Sammito G, Gemignani L, Bodini G, Savarino V. Characteristics of reflux episodes and symptom association in patients with erosive esophagitis and nonerosive reflux disease: study using combined impedance-pH off therapy. Am J Gastroenterol 2010; 105: 1053-1061 [PMID: 19997095 DOI: 10.1038/ ajg.2009.670]
8 Galniche JP, Clouse RE, Balmont A, Cook JI, Kahrilas PJ, Paterson WG, Smout AJ. Functional esophageal disorders. Gastroenterology 2006; 130: 1459-1465 [PMID: 16678559 DOI: 10.1053/ j.gastro.2005.08.060]
9 Katz PO, Gerson LB, Vela MF. Guidelines for the diagnosis and management of gastroesophageal reflux disease. Am J Gastroenterol 2013; 108: 308-328; quiz 329 [PMID: 23419381 DOI: 10.1038/ajg.2012.444]
10 Kara MA, Peters FP, Ten Kate FJ, Van Deventer SJ, Fockens P, Bergman JJ. Endoscopic video autofluorescence imaging may improve the detection of early neoplasia in patients with Barrett’ s esophagus. Gastrointest Endosc 2005; 61: 679-685 [PMID: 15855971 DOI: 10.1016/S0006-5195(04)02575-7]
11 Curvers WL, Alvarez Herrero L, Wallace MB, Wong Kee Song LM, Ragunath K, Wolfson HC, Prasad GA, Wang KK, Subramanian V, Weusten BL, Ten Kate FJ, Bergman JJ. Endoscopic tri-modal imaging is more effective than standard endoscopy in identifying early-stage neoplasia in Barrett’s esophagus. Gastroenterology 2010; 139: 1106-1114 [PMID: 20660033 DOI: 10.1053/j.gastro.2010.06.045]
12 Curvers WL, Singh R, Song LM, Wolfson HC, Ragunath K, Wang K, Wallace MB, Fockens P, Bergman JJ. Endoscopic tri-modal imaging for detection of early neoplasia in Barrett’s esophagus: a multi-centre feasibility study using high-resolution endoscopy, autofluorescence imaging and narrow band imaging incorporated in one endoscopy system. Gut 2008; 57: 167-172 [PMID: 17965067 DOI: 10.1136/gut.2007.134213]
13 van den Broek FJ, Fockens P, van Eeden S, Reitsma JB, Hardwick JC, Stokkers PC, Dokker E, Subramanian V. Endoscopic tri-modal imaging for surveillance in ulcerative colitis: randomised comparison of high-resolution endoscopy and autofluorescence imaging for neoplasia detection; and evaluation of narrow-band imaging for classification of lesions. Gut 2008; 57: 1083-1089 [PMID: 18367559 DOI: 10.1136/gut.2007.144007]
14 Morichi K, Fujiya M, Iijii M, Tanaka K, Sakatani A, Dokoshi T, Fujibayashi S, Ando K, Nomura Y, Ueno N, Kashima S, Gotoh T, Sasajima J, Iwabuchi T, Oo T, Tanabe H, Saitoh Y, Kohyo Y. Quantification of autofluorescence imaging can accurately and objectively assess the severity of ulcerative colitis. Int J Colorectal Dis 2015; 30: 1639-1643 [PMID: 26264047 DOI: 10.1007/ s00384-015-2332-5]
15 Osada T, Arakawa A, Sakamoto N, Ueyama H, Shibuya T, Ogihara T, Yao T, Watanabe S. Autofluorescence imaging endoscopy for identification and assessment of inflammatory ulcerative colitis.
