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Original Article

The place of ultrasonographic imaging in the follow-up of *Helicobacter pylori* infection after diagnosis and treatment

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ABSTRACT

Aims: The objective of this prospective study was to determine the USG findings of antral gastritis caused by *Helicobacter pylori (H. pylori)* infection and to determine the role of ultrasonographic imaging in the follow-up after diagnosis and treatment of this infection.

Methods: This prospective study included patients who were showing symptoms and signs of *H. pylori* infection and were diagnosed with *H. pylori* infection by endoscopic biopsy between November 2022 and October 2023.

The gastric wall thickness was measured and recorded while the patient was in supine position from the anterior wall of the antrum just to the right of the midline using the left lobe of the liver as an acoustic window.

Results: After evaluation of the biopsy samples taken during endoscopic examination, the participants were categorized into 3 groups. The antrum wall thickness was significantly higher in group 2 patients compared to the other two groups. However, no statistically significant difference was found between group 1 and group 3 (group 1-2 $p<0.05$, group 1-3 $p=0.234$, group 2-3 $p<0.05$). The diagnostic value of gastric antrum wall thickness for the diagnosis of H. pylori infection was statistically significant in the ROC curve analysis test with an AUC value of 0.933 within the 95% confidence interval, $p<0.001$.

Conclusion: Our results suggest that USG can detect gastritis caused by *H. pylori* infection and therefore USG may be useful in the follow-up of these patients after diagnosis and treatment.

Keywords: *Helicobacter pylori*, ultrasonography, antral gastritis

INTRODUCTION

Helicobacter pylori (*H. pylori*) is an infectious agent that colonizes in the human stomach, infecting more than half of the world's population, usually causing antral gastritis. However, in some cases, it can cause the development of gastroduodenal diseases such as peptic ulcer, gastric adenocarcinoma and lymphoid tissue lymphoma associated with the gastric mucosa.[1-4] While the incidence varies from region to region, it is one of the most common chronic infectious agents worldwide.[5] The most important risk factors include poor hygiene conditions, low socioeconomic status, crowded environment, contaminated water and food consumption.[6,7] Moreover, albeit not conclusive, the high prevalence in crowded living environments suggests fecal-oral transmission.[8] While the majority of people infected with *H. pylori* develop gastritis, the gastric antrum is the first and most common site of inflammation. Several invasive and non-invasive diagnostic methods are used for the diagnosis of this infection, but none of them is recognized as the gold standard in clinical practice.[9] With effective and long-term treatment, it is possible to eradicate more than 90% of H. pylori.[10]

The inflammation caused by *H. pylori* infection results in thickening of the gastric wall including the mucosal and submucosal layer.[11] The most significant sign of gastrointestinal diseases on radiologic imaging is in most cases increased wall thickness. Following recent technical advances, ultrasonography (USG) has become more important for the diagnosis of different gastrointestinal diseases. USG offers a significant advantage over endoscopy and contrast radiography for its ability to assess changes around the area under examination. In addition, USG provides more detailed information on intestinal wall layers than cross-sectional examinations.[12] Other advantages include easy accessibility, absence of radiation and generally no requirement for pre-procedural preparation.

The objective of this prospective study was to determine the USG findings of antral gastritis caused by *H. pylori* infection and to determine the role of ultrasonographic imaging in the follow-up after diagnosis and treatment of this infection.

METHODS

The study was conducted with the approval of Siirt University Non-invasive Ethics Committee (Date: 2023, Decision No: 80519). We obtained an informed consent form from all patients for procedure. All procedures were carried out in accordance with the ethical rules and the principles of the Declaration of Helsinki.

This prospective study included patients who were showing symptoms and signs of *H. pylori* infection and were diagnosed with *H. pylori* infection by endoscopic biopsy between November 2022 and October 2023. The control group included patients with dyspeptic complaints but without *H. pylori* infection or any gastric pathology on endoscopic biopsy. Patients scheduled for endoscopic examination were referred to our radiology unit before the procedure and an experienced radiologist, who was unaware of the clinical features of the patients, performed transabdominal ultrasonography. Demographics such as age, gender, BMI and smoking history were obtained. Patients younger than 18 years of age, with any known systemic disease, with a prior history of drug use for *H. pylori* infection, who received any systemic antibiotic treatment in the last 3 months, with any known history of malignancy, with a history of gastric surgery, diagnosed with inflammatory bowel disease and with ulcer, malignancy or lymphoma detected during endoscopic procedure were excluded from the study.

Under normal conditions, visualization of the entire stomach is not possible with transabdominal ultrasonography. We therefore preferred the gastric antrum as the measurement site, which is more easily visualized behind the left lobe of the liver and in front of the body of the pancreas. The gastric wall thickness was measured and recorded while the patient was in supine position from the anterior wall of the antrum just to the right of the midline using the left lobe of the liver as an acoustic window (Image). Patients diagnosed with *H.pylori* infection by endoscopic biopsy were initiated on appropriate dose and duration of medical treatment. All patients received a classical 14-day triple therapy protocol consisting of PPI 2×40 mg/day + amoxicillin-clavulanic acid 2×1000 mg/day + clarithromycin 2×500 mg/day. Patients with a history of drug allergy or who were intolerant to the treatment were excluded from the study. After treatment, the same radiologist re-measured the gastric antrum wall thickness using the previous measurement technique and recorded the results. All measurements were performed on a Samsung RS80 EVO (Samsung Medison Co., Ltd., Seoul, Korea) RDUS device using a linear probe with a frequency of 14 MHz.

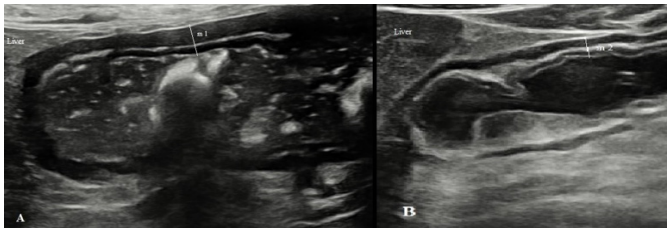

Image: The gastric antrum of a patient with epigastic pain who was diagnosed with H.pylori after endoscopic biopsy is shown by transabdominal ultrasonography before (Picture A) and after treatment (Picture B). The patient had increased antral wall thickness (m1=7.6 mm) which regressed after appropriate treatment (m2=4.3 mm).

Statistical Analysis

SPSS 20.0 program (Statistical Package for the Social Sciences, Chicago, IL) was used for data analysis. During the evaluation of the study data, the conformity of continuous variables to normal distribution was examined by Shapiro-Wilk test. Student's t test was used for paired independent group comparisons and one-way ANOVA was used for comparisons of more than two groups followed by TUKEY test for intergroup differences. The relationship between categorical variables was addressed using Pearson correlation coefficient. The significance level for statistical results was considered as $p<0.05$.

Receiver-operating-characteristic (ROC) curve analysis was used to estimate the diagnostic value of gastric antrum wall thickness in patients with *H. pylori* infection. For the prediction of different models, area under the curve (AUC), cut-off, sensitivity and specificity values were determined.

RESULTS

After evaluation of the biopsy samples taken during endoscopic examination, the participants were categorized into 3 groups. Group 1 included 82 cases without *H. pylori* infection or any pathology on biopsy, group 2 included 122 cases with *H. pylori* infection on biopsy, and group 3 included 109 cases with *H. pylori* infection on biopsy who received treatment and were followed up after treatment.

Demographics such as age, gender, BMI, smoking history and antral wall thickness of the 3 groups were compared (Table 1).

Table 1. Comparison of Intergroup Demographics

Parameter	Group 1 (n=82)	Group 2 (n=122)	Group 3 (n=109)	p
Age, y	39.7±13.2	41.8±13.2	42.1±12.3	.382
Female, n (%)	38(46.3)	64(52.5)	55(50.4)	.800
Male, n (%)	44(53.7)	58(47.5)	54(49.6)	.906
BMI, kg/m²	24.9±3.5	24.1±4.6	24.3±4.6	.351
Smoking, packs/y	12.5±12.9	15.1±16.4	14.1±14.9	.473

SD; Standard deviation, y; year, BMI; Body mass index

No significant difference was found between the groups in terms of age, gender, BMI and smoking habits. Anova was performed to test whether there was a significant intergroup difference in antral wall thickness and the test showed a significant difference between the groups. Tukey test was used to determine the direction of the difference. The antrum wall thickness was significantly higher in group 2 patients compared to the other two groups. However, no statistically significant difference was found between group 1 and group 3 (group 1-2 $p<0.05$, group 1-3 $p=0.108$, group 2-3 $p<0.05$)

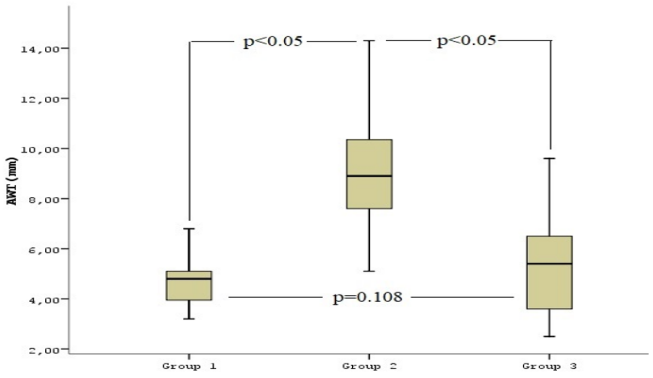

Figure 1. Box plots show the antral wall thickness (AWT) values between group 1 (control group), group 2 (patients with H. pylori before treatment) and group 3 (patients with H. pylori after treatment). The horizontal lines inside each box represent the mean values and the bottom and top rows of each box the minimum and maximum values respectively

(Figure 1 and Table 2).

Table 2. Comparison of antral wall thickness (AWT) values in groups 1, 2 and 3

	Group 1 (n=82)	Group 2 (n=122)	Group 3 (n=109)	p
AWT (mm)±SD	4.76±1.02	9.13±2.11	5.28±1.75	<0.05[a]
Group 1 ve Group 2				<0.05[b]
Group 1 ve Gorup 3				0.108[b]
Group 2 ve Group 3				<0.05[b]

[a]p<0.05 was considered statistically significant (one-way ANOVA).
[b]p<0.05 was considered statistically significant (one-way ANOVA with a post hoc Tukey test).

The diagnostic value of gastric antrum wall thickness for the diagnosis of *H.pylori* infection was statistically significant in the ROC curve analysis test with an AUC value of 0.946 within the 95% confidence interval, p<0.001 (Figure 2).

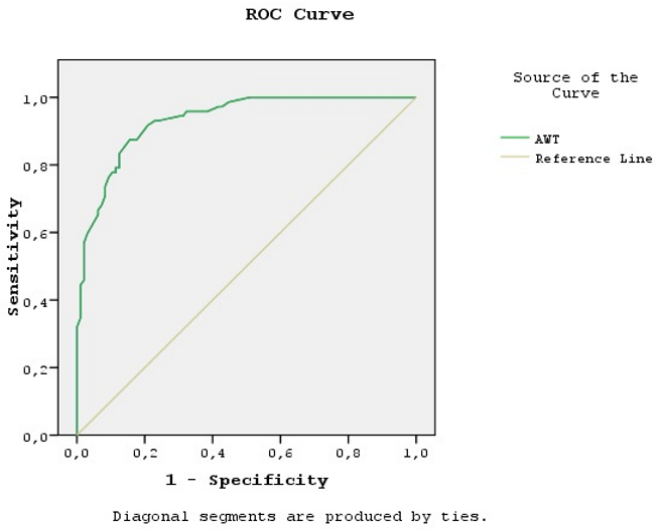

Figure 2. Receiver operating characteristics (ROC) analysis curve of antral wall thickness (AWT) in the diagnosis of *H. pylori* infection

Optimal diagnostic accuracy was determined at values selected for the best odds ratio.

DISCUSSION

The objective of this study was to present transabdominal ultrasonographic findings that may be useful in the diagnosis and treatment of *H. pylori* infection. We hope that confirmation of these results may help in the follow-up of the infection after diagnosis and treatment.

The most common cause of gastric wall thickening is *H. pylori* gastritis.[13] Along with recent technical advances, it is now possible to detect various morphologic features of the gastric walls by USG. Many studies have reported the antrum as the most suitable gastric region for sonographic examination.[1-16] While there is no clinical symptom specific to *H. pylori* infection, the most common symptoms include epigastric pain, dyspeptic complaints, feeling of hunger, bad breath or burning sensation in the stomach. Eradication of the infection is achievable with appropriate treatment which results in a significant reduction of the disease.[11] *H. pylori* infection induces inflammatory changes in the gastric mucosa. Initially, there is involvement of the deep mucosal layer and superficial muscularis mucosa, resulting in gastritis. Due to chronic exposure and high acid environment over time, inflammation spreads to the muscularis mucosa and results in thickening of this layer.[11,17] In their study, Cakmakci et al. found that both the antral wall and mucosal layer increased on sonographic examination in patients with *H. pylori* infection.[11] Consistent with the literature, patients with *H. pylori* infection in our study also had significantly thicker antral wall structure compared to the control group.

Invasive and non-invasive methods are used for the diagnosis of *H. pylori* infection. None of these tests can make a definitive diagnosis. Therefore, at least dual combinations of these tests are recommended for diagnosis, where applicable.[18] Non-invasive methods include urea breath test, serological tests and stool antigen screening. Urea breath test is a reliable non-invasive method to detect urease activity. This test is important as it shows active infection, is rapid and evaluates the response to treatment at an early stage. The most important disadvantages are its high cost and decreased diagnostic value after prior use of antibiotics, proton pump inhibitors or bismuth compounds.[19,20] Serologic tests are a method for detecting antibodies produced by the immune system against the infection by ELISA (enzyme-linked immunosorbent assay). The most important advantages of this method are that it is fast, cheap and easily accessible, while its drawback is poor capacity to detect eradication after treatment.[21] Stool antigen testing is an easy and inexpensive test based on the detection of bacterial antigen in stool by ELISA. It is used to assess eradication after diagnosis and treatment. However, cross-reaction with other *Helicobacter* species in the digestive system constitutes its most important disadvantage.[21] Invasive methods are based on the culture, histopathologic examination, PCR (polymerase chain reaction) and urease tests of the material taken after the endoscopic procedure. Culture is one of the most reliable diagnostic methods that allows the determination of bacterial characteristics and antibiotic susceptibility. Biopsy material is cultivated on a selective medium. However, the long isolation period, laborious and expensive nature are the most important disadvantages.[21-23] Histopathologic examination allows histopathologic study of materials taken from different parts of the stomach. This high sensitive test may give false-negative results in the presence of insufficient bacteria or if the material is taken from the wrong place.[21] The urease test is a method where biopsy material is placed in urea-containing medium to indirectly demonstrate that *H. pylori* produces urease. It is a rapid and reliable test with low post-treatment sensitivity.[24] The polymerase chain reaction is an easy and rapid method that can detect the presence of bacteria even with very small amounts of biopsy specimens. However, an important disadvantage is that it cannot be used in every laboratory.[21,22]

As mentioned above, each test for the detection of *H. pylori* comes with its own advantages and disadvantages. The choice of test for each patient is based on factors that may affect the results of the test, such as cost, clinical status, differences in test performance and antibiotic use.[25] Therefore, given that sonography is a non-invasive, safe, inexpensive and practical examination method, we believe that our sonographic findings will have a significant contribution to the diagnosis of *H. pylori* infection.

Thickening of the gastric wall is the most determinant finding of gastritis and has been demonstrated to improve after appropriate treatment.[9] In this study, we observed that the antrum wall thickness decreased in the control sonographs after appropriate treatment administered to

patients with *H. pylori* infection and there was no statistically significant difference with the control group. From this perspective, we suggest that sonography may have an important role not only in the diagnosis but also in the post-treatment control and follow-up of the infection. Also, to our knowledge, our study is the first to evaluate post-treatment eradication by trasabdominal ultrasonography.

Our study shows that the antrum wall thickness can have a diagnostic power to differentiate patients with *H. pylori* infection with 85% sensitivity and 73% specificity when a cut-off value of 6.9 mm is taken.

Our study had several limiting factors. Firstly, due to the small number of patients, our results should be supported by prospective and controlled studies with a larger patient population. Second, our study was conducted on Caucasian participants from a specific region, so it may not be generalizable to populations of different origins. Third, some of the demographics such as age, gender, height that may affect wall thickness and atrophic changes in the gastric wall that may develop as a result of chronic inflammation due to *H. pylori* infection were not considered in this study. Fourth, a uniform treatment protocol is applied to all patients to eliminate treatment variability.

CONCLUSION

Our results suggest that USG can detect gastritis caused by *H. pylori* infection and therefore USG may be useful in the follow-up of these patients after diagnosis and treatment. As sonography is particularly fast and easily accessible, it can prevent delays in treatment and some unnecessary examinations.

ETHICAL DECLARATIONS

Ethics Committee Approval: The study was conducted with the approval of Siirt University Non-invasive Ethics Committee (Date: 2023, Decision No: 80519).

Informed Consent: All patients signed the free and informed consent form.

Referee Evaluation Process: Externally peer-reviewed.

Conflict of Interest Statement: The authors have no conflicts of interest to declare.

Financial Disclosure: The authors declared that this study has received no financial support.

Author Contributions: All of the authors declare that they have all participated in the design, execution, and analysis of the paper, and that they have approved the final version.

REFERENCES

1. Mezmale L, Coelho LG, Bordin D, Leja M. Epidemiology of Helicobacter pylori. *Helicobacter.* 2020;25:e12734.
2. Lee YC, Dore MP, Graham DY. Diagnosis and treatment of Helicobacter pylori infection. *Annu Rev Med*. 2022;73:183-195.
3. Eusebi LH, Zagari RM, Bazzoli F. Epidemiology of Helicobacter pylori infection. *Helicobacter.* 2014;19(1):1-5.
4. Kekilli M, Onal IK, Ocal S, Dogan Z, Tanoglu A. Inefficacy of triple therapy and comparison of two different bismuth-containing quadruple regimens as a firstline treatment option for helicobacter pylori. *Saudi J Gastroenterol*. 2016;22(5):366.
5. McFarland LV, Huang Y, Wang L, Malfertheiner P. Systematic review and meta-analysis: multi-strain probiotics as adjunct therapy for Helicobacter pylori eradication and prevention of adverse events. *United European Gastroenterol J.* 2016;4(4):546-561.
6. Amaral O, Fernandes I, Veiga N, et al. Living conditions and Helicobacter pylori in adults. *Biomed Res Int.* 2017;2017:9082716.
7. Kaplan M, Tanoglu A, Düzenli T, Tozun AN. Helicobacter pylori treatment in Turkey: current status and rational treatment options. *Northern Clin İstanbul*. 2019;7(1):87-94.
8. Dunn BE, Cohen H, Blaser MJ. *Helicobacter pylori. Clin Microbiol Rev.* 1997;10:720-741.
9. Wang YK, Kuo FC, Liu CJ, et al. Diagnosis of *Helicobacter pylori* infection: current options and developments. *World J Gastroenterol.* 2015;21(40):11221-11235.
10. Ford AC, YuanY, Moayyedi P. *Helicobacter pylori* eradication therapy to prevent gastric cancer: systematic review and meta-analysis. *Gut*. 2020;69(12):2113-2121.
11. Cakmakci E, Ucan B, Colak B, Cinar HG. Novel sonographic clues for diagnosis of antral gastritis and *Helicobacter pylori* infection: a clinical study. *J Ultrasound Med*. 2014;33(9):1605-1610.
12. Hollerweger A, Dirks K, Szopinski K. Transabdominal ultrasound of the gastrointestinal tract. *EFSUMB Course Book Ultrasound*. 2012;233-271.
13. Zaher T, Refaey MM, Dawod HM, Abo Warda MH, Elfeky MA, Amer SA. The assessment of gastric antral wall thickness in *Helicobacter pylori* gastritis by abdominal ultrasonography, case-control study (2016-2018). *Afro-Egyptian J Infect Endemic Dis*. 2020;10(2):141-150.
14. Sijbrandij LS, Op den Orth JO. Transabdominal ultrasound of the stomach: a pictorial essay. *Eur J Radiol*. 1991;13(2):81-87.
15. Perlas A, Chan VW, Lupu CM, Mitsakakis N, Hanbidge A. Ultrasound assessment of gastric content and volume. *Anesthesiol*. 2009;111(1): 82-89.
16. Sporea I, Popescu A. Ultrasound examination of the normal gastrointestinal tract. *Med Ultrason*. 2010;12(4):349-352.
17. Perlas A, Davis L, Khan M, Mitsakakis N, Chan VW. Gastric sonography in the fasted surgical patient: a prospective descriptive study. *Anesth Analg.* 2011;113(1):93-97.
18. Krogfelt KA, Lehours P, Megraud F. Diagnosis of *Helicobacter pylori* infection. *Helicobacter.* 2005;10:5-13.
19. Sandıkçı M. Gastrit, peptik ülser ve *H. pylori*. Willke AT, Söyletir G, Doğanay M, (editörler), İçinde: İnfeksiyon Hastalıkları ve Mikrobiyolojisi, Nobel Tıp Kitabevleri, İstanbul, 2002:787-792.
20. Logan RP, Polson RJ, Misiewicz JJ, et al. Simplified single sample 13Carbon urea breath test for *Helicobacter pylori*: comparison with histology, culture, and ELISA serology. *Gut*. 1991;32(12):1461-1464.
21. Tünger Ö. *Helicobacter pylori* infeksiyonlari. *İnfeksiyon Dergisi*. 2008; 22(1):107-115.
22. Dunn BE, Cohen H, Blaser MJ. *Helicobacter pylori. Clin Microbiol Rev.* 1997;10:720-741.
23. Buyuk F, Karakaya E, Akar M, et al. A comprehensive study of Helicobacter pylori infection: molecular analysis, antibacterial susceptibility, and histopathological examination. *Antonie van Leeuwenhoek*. 2023;116(12):1261-1273.
24. Sousa C, Ferreira R, Santos SB, Azevedo NF, Melo LD. Advances on diagnosis of *Helicobacter pylori* infections. *Critic Rev Microbiol.* 2023; 49(6):671-692.
25. Hunt RH, Xiao SD, Megraud F, et al. *Helicobacter pylori* in developing countries. *J Gastrointestin Liver Dis*. 2011;20(3):299-304.