Can eradication rate of gastric *Helicobacter pylori* be improved by killing oral *Helicobacter pylori*?

Han-Yi Song, Yan Li

Han-Yi Song, Yan Li, Department of Gastroenterology, Shengjing Hospital of China Medical University, Shenyang 110004, Liaoning Province, China

Author contributions: Song HY designed the study, analyzed the data and wrote the manuscript; Song HY and Li Y carried out the study; Li Y contributed the reagents and analytic tools.

Correspondence to: Yan Li, MD, PhD, Chief of Department of Gastroenterology, Shengjing Hospital of China Medical University, Shenyang 110004, Liaoning Province, China. Yanli0227@126.com Telephone: +86-24-966152-6111 Fax: +86-24-966152-6111 Received: February 17, 2013 Revised: June 1, 2013 Accepted: July 4, 2013 Published online: October 21, 2013

Abstract

AIM: To evaluate the influence of oral *Helicobacter pylori* (*H. pylori*) on the success of eradication therapy against gastric *H. pylori*.

METHODS: A total of 391 patients with dyspepsia were examined for *H. pylori* using the saliva *H. pylori* antigen test (HPS), ¹³C-urea breath test (UBT), gastroscope, and gastric mucosal histopathological detection. Another 40 volunteers without discomfort were subjected to HPS and ¹³C-UBT, and served as the control group. The 233 patients who were ¹³C-UBT+ were enrolled in this study and divided into 4 groups. Patients who were HPS− and ¹³C-UBT− (n = 53) received triple therapy alone. Those who were both HPS+ and ¹³C-UBT+ (n = 180) were randomly divided into 3 groups: (1) the O+G+t group which received triple therapy alone (n = 53); (2) the O+G+tm group which received both triple therapy and mouthrinse treatment (n = 65); and (3) the O+G+tmp group which received triple therapy, mouthrinse, and periodontal treatment (n = 62). The HPS and ¹³C-UBT were continued for 4 wk after completion of treatment, and the eradication rate of gastric *H. pylori* and the prevalence of oral *H. pylori* in the 4 groups were then compared.

RESULTS: The eradication rates of gastric *H. pylori* in the O-G+t group, the O+G+tm group, and the O+G+tmp group were 93.3%, 90.0%, and 94.7% respectively; all of these rates were higher than that of the O-G+t group (78.4%) [O-G+t group vs O+G+t group (P = 0.039); O+G+tm group vs O+G+t group (P = 0.092); O+G+tmp group vs O+G+t group (P = 0.012); O+G+tm group vs O-G+t group (P = 0.546); O+G+tmp group vs O-G+t group (P = 0.765); O+G+tm group vs O+G+tmp group (P = 0.924)]. The eradication of gastric *H. pylori* was significantly improved using the combination of triple therapy, mouthrinse, and periodontal treatment. The eradication rates of gastric *H. pylori* in the peptic ulcer group, chronic atrophic gastritis group and control group were higher than in the duodenitis group and the superficial gastritis group. The prevalence rates of oral *H. pylori* in the O-G+t group, O+G+t group, O+G+tm group and O+G+tmp group following treatment were 0%, 76.5%, 53.3%, and 50.9%, respectively; all of these rates were higher than in the duodenitis group and the superficial gastritis group. The prevalence rates of oral *H. pylori* in the O-G+t group, O+G+t group, O+G+tm group and O+G+tmp group were less than those of the O-G+t group (P < 0.0001; O+G+tm group vs O-G+t group (P = 0.011); O+G+tmp group vs O+G+t group (P = 0.006); O+G+tm group vs O-G+t group (P < 0.0001); O+G+tmp group vs O-G+t group (P < 0.0001); O+G+tm group vs O+G+tmp group (P = 0.790)]. Both mouthrinse and periodontal treatment significantly reduced the prevalence of oral *H. pylori*.

CONCLUSION: Mouthrinse treatment alone or combined with periodontal treatment can, to some extent, reduce the prevalence of oral *H. pylori* and improve the eradication rate of gastric *H. pylori*.

© 2013 Baishideng. All rights reserved.

Key words: *Helicobacter pylori*; Dental plaque; Eradication; Periodontal; Mouthrinse

Core tip: The average eradication rate of gastric *Helico-
**bacter pylori (H. pylori)** has decreased in recent years. However, some foreign studies have shown that the eradication rate of gastric *H. pylori* may be improved by eliminating the presence of oral *H. pylori* rather than increasing the dose of antibiotics. In most studies, *H. pylori* DNA was detected and used to confirm oral *H. pylori* infection, and later determine whether professional periodontal treatments were effective in killing oral *H. pylori*. To avoid the expensive and complicated techniques involved with this approach, the current study used a cost-effective and simple method to test for and eliminate oral *H. pylori*. This method can be used to prove the elimination of gastric *H. pylori*, and is practical for use in the clinic.

Song HY, Li Y. Can eradication rate of gastric *Helicobacter pylori* be improved by killing oral *Helicobacter pylori*? World J Gastroenterol 2013; 19(39): 6645-6650 Available from: URL: http://www.wjgnet.com/1007-9327/full/v19/i39/6645.htm DOI: http://dx.doi.org/10.3748/wjg.v19.i39.6645

**INTRODUCTION**

*Helicobacter pylori* (H. pylori) is believed to be one of the major factors responsible for chronic active gastritis, gastroduodenal ulcers, mucosa-associated lymphoid tissue lymphomas, and gastric cancers[1]. It was designated as a type I carcinogen by the World Health Organization in 1994 and approximately 50% of the world’s population is infected. The isolation of *H. pylori* from dental plaque by Krajde[2] in 1989 strongly suggested that both oral- and gastro-oral routes are important transmission modes of *H. pylori*, and that the oral cavity is an extra-gastric reservoir for *H. pylori*[3,4]. Several studies have suggested that oral *H. pylori* is associated with the presence of *H. pylori* positive; additionally, patients who are oral *H. pylori*-positive have a lower success rate of *H. pylori* eradication than patients who test negative for oral *H. pylori*[5,6]. Also, previous studies have shown that DNA samples obtained from oral *H. pylori* are very similar to those obtained from corresponding gastric *H. pylori*[7,8]. The prevalence of *H. pylori* is related to an individual’s quality of oral hygiene and periodontal status, such as the presence of dental plaque and periodontal pockets[9], and the eradication rate of gastric *H. pylori* can be increased by controlling dental plaque and improving oral hygiene[10,11]. In our study, the saliva *H. pylori* antigen test (HPS) and the *13C*-urea breath test (*13C-UBT*) were used to detect oral and gastric *H. pylori* infections, respectively, and in this report, the term HPS+ signifies the presence of oral *H. pylori* infection, while *13C-UBT+* signifies the presence of gastric *H. pylori* infection. *13C-UBT+* patients were recruited for this study. HPS- cases were treated with triple therapy alone, while HPS+ cases were randomly distributed into 3 groups which received different treatments. The goal of this study was to evaluate the influence of oral *H. pylori* on the success of eradication therapy against gastric *H. pylori*.

**MATERIALS AND METHODS**

**Patient population**

From August 2011 to July 2012, outpatients with dyspepsia seen at the Department of Gastroenterology, Shengjing Hospital of China Medical University, Shenyang, China, were recruited and selected for this study. Exclusion criteria included a past history of *H. pylori* eradication therapy; treatment with antibiotics, H2 receptor blockers, bismuth or proton pump inhibitors within one month of study enrollment; the presence of severe periodontal disease; presence of an immune disease; current pregnancy; age ≤ 18 years; and the use of immune depressant drugs. A total of 391 eligible patients were enrolled in the study and another 40 volunteers without discomfort were enrolled to serve as a control group (Table 1).

The diseases listed in Table 1 were diagnosed using the following criteria: Peptic ulcer was defined as the presence of gastric ulcer and/or duodenal ulcer. Chronic atrophic gastritis: Endoscopy showed good visualization of the submucosal vessel in the antrum and in the body. Histopathology showed the loss of appropriate glands or the presence of metaplasia. Duodenitis: During endoscopy, the duodenal bulb mucosa appeared abnormally congested, edematous, or roughened in the absence of an ulcer or scar. Histopathology showed nuclear atypia of the glandular epithelium and infiltration by neutrophils. Superficial gastritis: During endoscopy, gastric mucosa appeared abnormally congested, edematous, or roughened. Histopathology showed nuclear atypia of the glandular epithelium and infiltration by neutrophils.

**Study groups**

Each subject was evaluated by HPS, *13C-UBT*, gastroscopy, and gastric mucosal histopathological examination. Two biopsy specimens were taken from the greater curvature of both the antrum and the body of the stomach, respectively. Another 2 biopsy specimens were taken from both the lesser curvature of the antrum and body, respectively. Patients who were HPS- and *13C-UBT+* (n = 53) received triple therapy alone. Those who were both HPS+ and *13C-UBT+* (n = 180) were randomly divided into 3 groups: (1) the O+G+t group which received triple therapy alone (n = 53); (2) the O+G+tm group which received triple therapy and mouthrinse treatment (n = 65); and (3) the O+G+tmp group which received triple therapy, mouthrinse, and periodontal treatment (n = 62). The triple therapy consisted of amoxicillin (1.0 g) and esomeprazole (20 mg), twice a day, and levofloxacin (0.5 g), once a day, given for 10 d. Mouthrinse (brand name Chlorhexidine Gargle), (Shenzhen Nanyue Pharmaceutical Co., Ltd., Shenzhen, China) was purchased from a drugstore. This mouthwash contained 0.02% tinidazole and 0.12% chlorhexidine, and a 20 mL volume was held in the mouth for 5 min and then spat out, for 10 d. Periodontal therapy consisted of plaque and calculus removal with an ultrasonic device twice a month in the Depart-
song hy et al. oral h. pylori influences gastric eradication rate

Figure 1 Study design schematic and study measures.

### Table 1 Characteristics of the 431 patients

| Diseases               | Total | Male | Female | Age range (yr) Mean age (yr) |
|------------------------|-------|------|--------|-----------------------------|
| Peptic ulcer           | 54    | 40   | 14     | 20-80, 51.1                 |
| Chronic atrophic gastritis | 48    | 32   | 16     | 46-82, 58.5                 |
| Duodenitis             | 58    | 31   | 27     | 26-77, 51.0                 |
| Superficial gastritis  | 231   | 95   | 136    | 18-74, 49.6                 |
| Control group          | 40    | 17   | 23     | 18-67, 44.0                 |

The saliva H. pylori antigen test (Meili Taige Diagnostic Reagent Co., Ltd, Jiaxing, China) is a rapid immunochromatographic assay that uses antibody-coated colloidal gold to detect the presence of specific H. pylori antigens in the saliva specimen. Yee et al. clarified that HPS was designed to detect two H. pylori antigens: flagellin and urease. In Yee’s experiment, the HPS results were compared in parallel with the UBT, serum antibody, Campylobacter-like organism test, silver stain, culture, and stool antigen test results. The test’s sensitivity was 10 ng/mL H. pylori flagelin and urease antigen. There was no interference or cross-reactivity with the other bacteria in the oral cavity and there was statistical correlation between oral antigen and serum antibody test results. No food or drink was allowed 1 h before the test. To perform the test, four drops of saliva were added to the sampling cup using a pipette and two drops of PBS were added. After mixing, a new pipette was used to transfer four drops of the mixture into the sample well of the test cassette. The sample flowed through a label pad containing H. pylori antibody coupled to red-colored colloidal gold. If the sample contained H. pylori antigens, the antigen would bind to the antibody coated on the colloidal gold particles to form antigen-antibody-gold complexes. The complexes then moved on a nitrocellulose membrane by capillary action toward the test zone. A second control line always appeared in the result window to indicate that the test had been correctly performed and that the test device was functioning properly. The results were observed within 5-30 min. The occurrence of two bands in the test and control zones was positive for H. pylori. The occurrence of one band in the control zone was negative for H. pylori. If there was no band in the control zone, the samples were re-tested.

**13C-UBT**

An HG-IRIS13C infrared spectrometer and diagnostic kits (Beijing Pharmaceutical Co., Ltd) were used to detect gastric H. pylori. The test was judged positive when the detected value in the exhalation was larger than 4.

### Statistical analysis

Statistical analysis of data was performed with SPSS software 19.0. The χ² test was used to analyze the eradication rate of gastric H. pylori and the prevalence of oral H. pylori in each group. A P value ≤ 0.05 was considered statistically significant.

### RESULTS

#### Results of HPS and 13C-UBT testing

A total of 431 patients were tested using HPS and 13C-UBT methods, and the results are shown in Table 2.

The prevalence of gastric and oral H. pylori differed among the 5 disease groups. There was a reduced trend for the prevalence of gastric H. pylori starting from the peptic ulcer group and continuing to the control group, but no similar trend was seen for oral H. pylori (Figure 2).

#### Eradication rate of gastric H. pylori after treatment

Four weeks after completion of treatment, 213 patients returned for evaluation, and 20 patients did not return. The gastric H. pylori eradication rate in the O+G+t group was significantly lower than in the O-G+t and O+G+tmp groups (O-G+t group vs O+G+t group, P = 0.039), (O+G+tmp group vs O+G+t group, P = 0.012). The gastric H. pylori eradication rate in the O+G+tm group was higher than in the O-G+t group, but the difference was not statistically significant (P = 0.092). There were no statistical differences between the O-G+t and O+G+tm groups when compared to the O+G+tmp group (O+G+tm group vs O-G+t group, P = 0.546), O+G+tmp group vs O-G+t group, P = 0.765), and
to oral and stomach to oral routes has been recognized since 1989 when Krajde first isolated *H. pylori* from the dental plaque of patients with gastric diseases related to *H. pylori* infection. Further studies have shown that the gastric *H. pylori* eradication rate in patients with oral *H. pylori* infection is lower than that in patients without oral *H. pylori* infection. With the increase in antibiotic resistance which has occurred during the past 10 years, the rate of gastric *H. pylori* eradication following triple therapy has significantly decreased. From 1983-1997, the average eradication rate for gastric *H. pylori* was 75%-90%[37], but later decreased to 68.8% in the period from 1996 to 2005[38]. Improvements in the gastric *H. pylori* eradication rate produced by killing oral *H. pylori* can reduce the application of antibiotics[39,40], which not only reduces the economic burden of treatment, but also lowers the risk of increasing the resistance of *H. pylori* to antibiotics. Oral *H. pylori* is mainly present in periodontal pockets and dental plaque[39,40]. Zaric et al[41] collected dental plaque and gastric tissues and examined them for *H. pylori* using nested polymerase chain reaction (PCR). In our study, for patients with both oral and gastric *H. pylori*, periodontal treatment was applied in addition to triple therapy. Ultrasonic waves were used to remove dental plaque and calculi, and root surface scaling was used to eradicate the periodontal pockets. Glucose chlorhexidine solution (0.15%) was used to lavage the periodontal pocket. After periodontal treatment, the gastric *H. pylori* eradication rate was increased from 47.6% to 77.3%, while the prevalence of oral *H. pylori* was decreased from 66.7% to 27.0%; these results indicated that periodontal treatment could kill oral *H. pylori*. The methods used by Zaric were useful, but not easy to employ, and the monetary cost was high. Conducting nested PCR requires specific instruments, and the periodontal treatment also requires experienced dentists; therefore, these methods are not practical for routine clinical application. The current study was conducted to seek a cost-effective method for diagnosing oral *H. pylori* infection and reducing its prevalence.

Currently, there are two methods (bacterial culturing and nested PCR) used to diagnose oral *H. pylori* infection. Although the bacterial culture method has high specificity, large numbers of other oral bacteria can inhibit the growth of *H. pylori*, leading to a high false negative rate[42]. The nested PCR method has high sensitivity and
Table 4  Eradication rate of gastric Helicobacter pylori after treatment in all gastric disease groups  n (%) 

| Group        | Gastric diseases |
|--------------|------------------|
|              | Peptic ulcer     | Chronic atrophic gastritis | Duodenitis | Superficial gastritis | Control group |
| O+G+t        | 10 (100.0)       | 6 (100.0)                 | 2 (100.0)  | 19 (86.4)             | 5 (100.0)    |
| O+G+tm       | 9 (90.0)         | 7 (87.5)                  | 8 (72.7)   | 12 (70.6)             | 4 (80.0)     |
| O+G+tmp      | 9 (100.0)        | 10 (100.0)                | 9 (75.0)   | 22 (88.0)             | 4 (100.0)    |
|              | 5 (100.0)        | 5 (100.0)                 | 10 (91.0)  | 27 (93.1)             | 3 (100.0)    |

specificity, but the results have been highly variable due to the use of different primers, and it cannot differentiate between DNA from dead and living bacteria. Helicobacter pylori DNA can still be detected even if the bacteria are already dead[21,22]. Thus, the nested PCR method cannot monitor the therapeutic efficacy of a treatment for oral Helicobacter pylori.

The HPS test is a rapid immunochromatographic assay. The principle of this test kit is based on using a colloidal gold chromatography double antibody sandwich to detect Helicobacter pylori flagellae and urease in human saliva. There are no cross-reactions with the urease released by other oral bacteria[14].

Our results showed that the positive rate of HPS testing was 74.9%, demonstrating that the mouth is another storage site for Helicobacter pylori. In this study, the gastric Helicobacter pylori eradication rate in patients who were HPS+ was lower than that in patients who were HPS- (78.4% vs 93.3%). We also noted that the test results of gastric and oral Helicobacter pylori were not consistent. Previous studies have shown that Helicobacter pylori does not colonize in the mouth of a person who practices good oral hygiene (e.g., no periodontal disease, no gingival band or plaque) [6]. In this situation, the oral Helicobacter pylori titer is low and does not reach the threshold of gastric Helicobacter pylori infection. Therefore, a test to detect gastric Helicobacter pylori infection would give negative results. For gastric Helicobacter pylori-positive patients with good oral hygiene, although gastric Helicobacter pylori may be refueled into the mouth, the bacterium may not survive in the mouth. In this study, the HPS test had a high sensitivity, which enabled it to detect a low titer of Helicobacter pylori. Therefore, the positive rate for oral Helicobacter pylori infection was higher than that for gastric Helicobacter pylori infection.

Helicobacter pylori in the oral cavity is covered by a special protective shell called a biofilm, and systemic eradication therapy may not be very effective when used for treatment [23,24]. This study confirmed that hypothesis. The gastric Helicobacter pylori eradication rate in the O+G+t group was much higher than that in the oral Helicobacter pylori group (78.4% vs 23.5%). Compared with the O+G+tm group, the eradication rates of gastric Helicobacter pylori in the O+G+tm and O+G+tmp groups were elevated from 78.4% to 90.0% and 94.7%, respectively, while the prevalence of oral Helicobacter pylori was reduced from 76.5% to 53.3% and 50.9%, respectively. There was no significant difference in gastric Helicobacter pylori eradication rate between the O+G+tm group and the O+G+tmp group. The gastric Helicobacter pylori eradication rates in the peptic ulcer group, chronic atrophic gastritis group, and control group were higher than those in the duodenitis group and superficial gastritis group, but no conclusion could be drawn from this finding because the number of patients was small. This study demonstrated that mouthrinse treatment alone or combined with periodontal treatment could effectively reduce the prevalence of oral Helicobacter pylori, but did not prove a mechanism for this result. One hypothesis may be that the mouthrinse treatment or periodontal treatment reduced the amount of dental plaque and improved oral hygiene, thus enabling the titer of Helicobacter pylori to be reduced.

This study proved that mouthrinse treatment alone or combined with periodontal treatment could reduce the prevalence of oral Helicobacter pylori and improve the eradication rate of gastric Helicobacter pylori. The HPS test is a simple and rapid method that can diagnose oral Helicobacter pylori infection; however, the test results cannot be analyzed quantitatively. Therefore, the therapeutic effect of various treatments could not be thoroughly analyzed.

**COMMENTS**

**Background**
It is well acknowledged that the stomach can serve as a reservoir for Helicobacter pylori and that gastric Helicobacter pylori can be killed by triple or quadruple therapy. Increasing numbers of studies have suggested that the average eradication rate of gastric Helicobacter pylori has dropped in recent years, and it is important to find a practical way to improve the eradication rate.

**Research frontiers**
Since Krajde isolated Helicobacter pylori from dental plaque in 1989, many studies have demonstrated that the oral cavity serves as an extra-gastric reservoir for Helicobacter pylori. Several studies have suggested that patients who test positive for oral Helicobacter pylori have a lower success rate of gastric Helicobacter pylori eradication than oral Helicobacter pylori-negative individuals. Zaric used nested polymerase chain reaction (PCR) to test for the presence of oral Helicobacter pylori and improved the eradication rate of gastric Helicobacter pylori from 47.6% to 77.3% by removing dental plaque. However, the cost of this procedure was high and the process was complicated. There is a need to find a simple and rapid diagnostic test that can be used to confirm the presence of oral Helicobacter pylori infection and to identify a method that can increase the eradication rate of gastric Helicobacter pylori and is feasible for clinical application.

**Innovations and breakthroughs**
13C-UBT is the gold standard for diagnosis of gastric Helicobacter pylori infection; however, a unified method has not been identified for diagnosing oral Helicobacter pylori infection. Nested PCR, which tests the DNA of Helicobacter pylori, is commonly used, but has a high false positive rate because it cannot distinguish between DNA from dead and living bacteria. The current study replaced the nested PCR method with a saliva Helicobacter pylori antigen test (HPS) to test for oral Helicobacter pylori. The HPS test employs a monoclonal antibody that was developed against semipurified Helicobacter pylori protein, and in another experiment, this test showed no interference or cross reactivity with other oral bacteria. Zaric killed oral Helicobacter pylori by removing dental plaque and lavaging the periodontal pocket, which required a professional dentist. In the current study, mouthwash was used to effectively kill oral Helicobacter pylori.

**Applications**
This study used the saliva Helicobacter pylori antigen test to diagnose oral Helicobacter pylori infection. This test is simple to use and results are rapidly obtained. The eradication rate of gastric Helicobacter pylori improved significantly in patients who received mouth-
Objective: To investigate the eradication rate of gastric Helicobacter pylori ( Hp) infection after oral rinse and periodontal treatment among patients undergoing gastroscopy. Methods: The study was performed on 391 persons who underwent gastrosopy which included Hp testing, antibiotic therapy and Hp eradication test. The Hp testing was performed by rapid urease test, antigen detection in saliva (using rapid immunochromatographic assay) and histopathological examination of gastric mucosa. For evaluation of Hp eradication rate, the study is set up correctly. The paper is written well. The Introduction gives a good overview of the study background and the authors raised clearly the aim of the study. The material studied is large enough to draw the conclusions. The Tables and Figure give a good overview about the results.

Peer review
This is an interesting study, indicating a cheap way of improving Hp eradication rate. The study was performed on 391 persons who underwent gastroscopy and periodontal treatment could kill the oral Hp and improve the eradication rate of gastric Hp by triple therapy. The study is set up correctly. The paper is written well. The Introduction gives a good overview of the study background and the authors raised clearly the aim of the study. The material studied is large enough to draw the conclusions. The Tables and Figure give a good overview about the results.

REFERENCES
1. Correa P. Helicobacter pylori as a pathogen and carcinogen. J Physiol Pharmacol 1997; 48 Suppl 4: 19-24 [PMID: 9440052]
2. Krajden S, Fukusa M, Anderson J, Kempston J, Bocca A, Petrea C, Babida C, Karmali M, Penner J. Examination of human stomach biopsies, saliva, and dental plaque for Campylobacter pylori. J Clin Microbiol 1989; 27: 1397-1398 [PMID: 2754080]
3. Chow TK, Lambert JR, Wahlqvist ML, Hsu-Hage BH. Helicobacter pylori in Chinese immigrants: evidence for oral-oral transmission via chopsticks. J Gastroenterol Hepatol 1995; 10: 562-569 [PMID: 8963032 DOI: 10.1111/j.1440-1746.1995.tb01347.x]
4. Megraud F. Transmission of Helicobacter pylori: faecal-oral versus oral-oral route. Aliment Pharm Ther 1995; 9 Suppl 2: 85-91 [PMID: 8547533]
5. Cellini L, Grande R, Artlesi L, Marzio L. Detection of Helicobacter pylori in saliva and esophagus. New Microbiol 2010; 33: 351-357 [PMID: 21213594]
6. Zou QH, Li RQ. Helicobacter pylori in the oral cavity and gastric mucosa: a meta-analysis. J Oral Pathol Med 2011; 40: 317-324 [PMID: 21294774 DOI: 10.1111/j.1607-0931.2011.01060.x]
7. Al Asqah M, Al Hamoudi N, Anil S, Al Jebreen A, Al-Hamoudi WK. Is the presence of Helicobacter pylori in dental plaque of patients with chronic periodontitis a risk factor for gastric infection? Can J Gastroenterol 2009; 23: 177-179 [PMID: 1931981]
8. Miyabayashi H, Furihata K, Shimizu T, Ueno I, Akae K. Influence of oral Helicobacter pylori on the success of eradication therapy against gastric Helicobacter pylori. Helicobacter 2000; 5: 30-37 [PMID: 10672049 DOI: 10.1046/j.1525-5378.2000.00004.x]
9. Zoric S, Boje B, Jankovic Lj, Dapcevic B, Popovic B, Cakic S, Milasin J. Periodontal therapy improves gastric Helicobacter pylori eradication. J Dent Res 2009; 88: 946-950 [PMID: 19783805 DOI: 10.1177/002203450834599]
10. Assumaption MB, Martins LC, Melo Barbosa HP, Barile KA, de Almeida SS, Assumaption PP, Corvelo TC. Helicobacter pylori in dental plaque and stomach of patients from North-ern Brazil. World J Gastroenterol 2010; 16: 3033-3039 [PMID: 20572307 DOI: 10.3748/wjg.v16.i24.3033]
11. Wang J, Chi DS, Laffan JJ, Li C, Ferguson DA, Litchfield P, Thomas E. Comparison of cytotoxin genotypes of Heli-cobacter pylori in stomach and saliva. Dig Dis Sci 2002; 47: 1850-1856 [PMID: 12184541 DOI: 10.1023/A:1016417200611]
12. Banatvala N, Lopez CR, Owen R, Abdi Y, Davies G, Hardie J, Feldman R. Helicobacter pylori in dental plaque. Lancet 1993; 341: 380 [PMID: 8094153 DOI: 10.1016/0140-6736(93)0191-4]
13. Wichelslau A, Buschli L, Song Q, Adler G, Bode G. Prevalence of Helicobacter pylori in the adolescent oral cavity: dependence on orthodontic therapy, oral flora and hygiene. J Orofac Orthop 2011; 72: 187-195 [PMID: 21744197 DOI: 10.1007/s00056-011-0245-5]
14. Jia CL, Jiang G, Li CH, Li CR. Effect of dental plaque control on infection of Helicobacter pylori in gastric mucosa. Tex Dent J 2012; 129: 1069-1076 [PMID: 2331026]
15. Shmuel H, Yanov J, Sama Z, Chodick G, Koren R, Niv Y, Ofek I. Effect of cranberry juice on eradication of Helico-bacter pylori in patients treated with antibiotics and a proton pump inhibitor. Mol Nutr Food Res 2007; 51: 746-751 [PMID: 17487928 DOI: 10.1002/mnfr.200600281]
16. Yee KC, Wei MH, Yee HC, Everett KD, Yee HP, Hazeke-Talor N. A screening trial of Helicobacter pylori-specific antigen tests in saliva to identify an oral infection. Digestion 2013; 87: 163-169 [PMID: 23615458 DOI: 11.1511/00305432]
17. Laheji RJ, Rossoum LG, Jansen JB, Straatman H, Verbeek AL. Evaluation of treatment regimens to cure Helicobacter pylori infection--a meta-analysis. Aliment Pharm Ther 2019; 13: 857-864 [PMID: 10383518 DOI: 10.1046/j.1365-2036.1999.00542.x]
18. Kadayifci A, Buyukhatipoglu H, Cemil Savas M, Simsek I. Eradication of Helicobacter pylori with triple therapy: an epidemiologic analysis of trends in Turkey over 10 years. Clin Ther 2006; 28: 1960-1966 [PMID: 17213016]
19. Song Q, Lange T, Spahr A, Adler G, Bode G. Characteristic distribution pattern of Helicobacter pylori in dental plaque and saliva detected with nested PCR. J Med Microbiol 2000; 49: 349-353 [PMID: 10755629]
20. Agarwal S, Jittendra KD. Presence of Helicobacter pylori in subgingival plaque of periodontitis patients with and without dyspepsia, detected by polymerase chain reaction and culture. J Indian Soc Periodontol 2012; 16: 398-403 [PMID: 23162336 DOI: 10.4103/0972-124X.100919]
21. Ferguson DA, Li C, Patel NR, Mayberry WR, Chi DS, Thomas E. Isolation of Helicobacter pylori from saliva. J Clin Microbiol 1995; 31: 2802-2804 [PMID: 8253990]
22. Eskandari A, Mahmoudpour A, Abolfazli N, Lafzi A. Detection of Helicobacter pylori using PCR in dental plaque of patients with and without gastritis. Med Oral Patol Oral Cir Bucal 2010; 15: x28-e31 [PMID: 19766993]
23. Ricci C, Holton J, Vaira D. Diagnosis of Helicobacter pylori: invasive and non-invasive tests. Best Pract Res Clin Gastroenterol 2007; 21: 299-313 [PMID: 17382278 DOI: 10.1016/j.bpg.2006.11.002]
24. Song Q, Spahr A, Schmid RM, Adler G, Bode G. Helicobacter pylori in the oral cavity: high prevalence and great DNA diversity. Dis Dig Sci 2000; 45: 2162-2167 [PMID: 11215732]
25. Wilson M. Susceptibility of oral bacterial biofilms to anti-microbial agents. J Med Microbiol 1996; 44: 79-87 [PMID: 8642580 DOI: 10.1099/00222654-44-2-79]
26. Pytko-Polonczyk J, Konturek SJ, Karczewska E, Bielański W, Kaczmarczyk-Stachowska A. Oral cavity as permanent reservoir of Helicobacter pylori and potential source of reinfection. J Physiol Pharmacol 1996; 47: 121-129 [PMID: 8777292]

P- Reviewers: Linden SK, Tosetti C, Vorobjova T, Wang JT
S- Editor: Guo SY
E- Editor: Ma SY
