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Retrospective Cohort Study

Tailored eradication vs empirical bismuth-containing quadruple therapy for first-line *Helicobacter pylori* eradication: A comparative, open trial

Youn I Choi, Jun Won Chung, Dong Kyun Park, Kyoung Oh Kim, Kwang An Kwon, Yoon Jae Kim, Ja Young Seo

ORCID number: Youn I Choi (0000-0001-6561-6752); Jun Won Chung (0000-0002-0869-7661); Dong Kyun Park (0000-0002-2862-6641); Kyoung Oh Kim (0000-0002-5365-2550); Kwang An Kwon (0000-0002-2947-2111); Yoon Jae Kim (0000-0001-8477-6823); Ja Young Seo (0000-0002-1894-1365).

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Institutional review board

statement: The Institutional Review Board of Gil Medical Center reviewed the study protocol and ethics. This study was conducted in accordance with the Declaration of Helsinki, and the study protocol was approved by the Ethics Committee of each participating hospital.

Informed consent statement: Our study involved prospectively enrolled patients (open-label and comparative study), and retrospectively reviewed the patients' data which were usual clinical procedures for diagnosis of *Helicobacter pylori* infection and treatments. All patients provided informed consent regarding

Youn I Choi, Jun Won Chung, Dong Kyun Park, Kyoung Oh Kim, Kwang An Kwon, Yoon Jae Kim, Department of Gastroenterology, Gil Medical Center, Gachon University, Incheon 21565, South Korea

Ja Young Seo, Department of Laboratory Medicine, Gil Medical Center, Gachon University, Incheon 21565, South Korea

Corresponding author: Jun Won Chung, MD, PhD, Associate Professor, Doctor, Division of Gastroenterology, Department of Internal Medicine, Gachon University, Gil Medical Center, 21 Namdong-daero 774 beon-gil, Namdong-gu, Incheon 21565, South Korea.

junwonchung@hanmail.net

Telephone: +82-10-90041604

Abstract

BACKGROUND

Few studies have compared the efficacy and safety profile of a tailored eradication (TR) strategy based on the presence of a 23S ribosomal RNA point mutation with those of empirical bismuth-based quadruple therapy (EBQT) for first-line eradication of *Helicobacter pylori* (*H. pylori*) in Korean patients.

AIM

To compare the efficacy and safety of a TR strategy and those of EBQT regimen as first-line eradication therapy for *H. pylori*.

METHODS

This is an open-label, comparative study in which we prospectively enrolled patients over 18 years of age with *H. pylori* infection and retrospectively reviewed their data. *H. pylori*-positive patients diagnosed by rapid urease test, Giemsa staining, or dual priming oligonucleotide polymerase chain reaction (DPO-PCR) were enrolled from May 2016 to September 2018 at Gil Medical Center. Patients with *H. pylori* infection received either a TR regimen or the EBQT regimen. In the tailored therapy group that underwent DPO-PCR testing, patients with A2142G and/or A2143G point mutations were treated with a bismuth-containing quadruple regimen. The eradication rate, patient-reported side effect rate, and *H. pylori* eradication success rate were evaluated and compared between the groups.

RESULTS

esophagogastroduodenoscopy (EGD), EGD guided biopsy, histopathology test, rapid urease test, Giemsa staining, or dual priming oligonucleotide polymerase chain reaction (DPO-PCR) test, and tailored regimen.

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A total of 150 patients were assigned to the TR ($n = 50$) or EBQT group ($n = 100$). The first-line eradication rate of *H. pylori* did not differ between the groups (96.0% vs 95.7%, $P = 0.9$). The rate of eradication-related side effects for TR was 12.0%, which differed significantly from that of EBQT (43.0%) for first-line treatment ($P < 0.001$).

CONCLUSION

DPO-PCR-based TR for *H. pylori* eradication may be equally efficacious, with less treatment-related complications, compared to EBQT in Korea, where clarithromycin resistance is high.

Key words: *Helicobacter pylori*; Eradication; Tailored; Empirical; Quadruple

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Core Tip: Few studies have compared the efficacy and safety profile of a tailored eradication (TR) strategy based on the presence of a 23S ribosomal RNA point mutation with those of empirical bismuth-based quadruple therapy (EBQT) as first-line eradication therapy for *Helicobacter pylori* infection in Korean patients. In this prospective, open-label, comparative study and retrospectively reviewed the results, the first-line eradication rate of *Helicobacter pylori* (*H. pylori*) did not statistically differ between the strategies of TR and EBQT. However, the rate of eradication-related side effects associated with TR was significantly lower than that with EBQT. DPO-PCR-based TR for *H. pylori* eradication may be equally efficacious, with less treatment-related complications, compared to EBQT in Korea, where clarithromycin resistance is high.

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INTRODUCTION

Helicobacter pylori (*H. pylori*) is designated as a class I carcinogen by the International Agency for Research on Cancer and the World Health Organization, and it is a suspected cause of gastric adenocarcinoma or gastric mucosa-associated lymphoid tissue lymphoma^[1-4]. Although eradication of *H. pylori* has emerging importance, the eradication success rate for *H. pylori* using an empirical strategy has decreased worldwide^[5]. In addition, as the clarithromycin (CAM) resistance rate has surpassed 15% in Korea, and the metronidazole (MTZ) resistance rate has been reported at 30%, the eradication rate of the empirical triple regimen [proton pump inhibitor (PPI), amoxicillin (AMX), and CAM] has decreased to less than 70%^[6].

The Maastricht V/Florence Consensus guidelines recommend bismuth-containing quadruple therapy as the empirical treatment choice in countries with high dual resistance to CAM and MTZ^[7,8]. Although the 2013 revision of the Korean Clinical Practice Guidelines for *H. pylori* recommend triple therapy with PPI, AMX, and CAM or a bismuth-based quadruple regimen if CAM resistance is suspected^[9], there are emerging concerns for using a bismuth-based quadruple regimen in that (1) it is too complex a combination of too many antibiotics, which may lead to improper antibiotic overuse; and (2) diverse and enormous cases of treatment-related side effects may occur, resulting in poor patient compliance^[7,10-12]. One of the main reasons for the failure of *H. pylori* eradication is the increase in *H. pylori* antibiotic resistance rates along with improper antibiotic use^[13]; thus, a tailored eradication (TR) strategy design has been proposed to improve treatment-related outcomes^[14-18].

However, few studies have compared the efficacy, safety profiles, and compliance rates between a TR strategy based on the presence of a 23S ribosomal RNA point mutation and the empirical bismuth-based quadruple therapy (EBQT) as first-line eradication therapy for *H. pylori* infection in Korean patients.

Therefore, in this open-label, and comparative study, we investigated the efficacy

(eradication rate), safety profile (treatment-related side effects), and compliance rate of a TR strategy, based on the presence of a 23S ribosomal RNA point mutation, *vs* those of EBQT therapy as first-line eradication therapy for *H. pylori* infection in Korean patients.

MATERIALS AND METHODS

Institutional review board approval

The Institutional Review Board of Gil Medical Center (GMC) reviewed the study protocol and ethics. This study was conducted in accordance with the Declaration of Helsinki, and the study protocol was approved by the Ethics Committee of each participating hospital.

Study concept

In this open label, comparative study, we compared the efficacy (measured as eradication success rate) and safety profiles (eradication treatment-related complications) between TR and EBQT as first-line eradication treatment for *H. pylori*.

Patient characteristics

Patients who visited the GMC for an endoscopic examination between May 2016 and September 2018 and who were over 18 years of age and had a *H. pylori* infection were included in this study. *H. pylori* infection was diagnosed by the rapid urease test, Giemsa staining, or dual priming oligonucleotide polymerase chain reaction (DPO-PCR). The exclusion criteria were: (1) < 18 years of age; (2) Not willing to participate in this study; (3) Previous eradication treatment for *H. pylori*; (4) History of gastric surgery; (5) Complex medical history, such as severe cardiopulmonary dysfunction, liver cirrhosis with Child Pugh classification B or C, or renal failure, or (6) Any allergic history to antibiotics.

The patients with *H. pylori* infection were assigned to either a TR group or an EBQT group in a 1:2 manner. In the tailored therapy group that underwent DPO-PCR testing, patients with A2142G and/or A2143G point mutations were treated with the BQT regimen (PPI + bismuth + MTZ + tetracycline), and patients without A2142G and A2143G point mutations were treated with the PAC regimen (PPI + AMX + CAM).

Clarithromycin resistance test (DPO-PCR)

In the TR group, DPO-PCR was performed using the following steps^[19-21]: (1) DNA was extracted from biopsy specimens and DPO-based multiplex PCR (Seeplex *H. pylori*-ClaR ACE Detection; Seegene Inc., Seoul, South Korea) was performed; (2) Point mutations were identified by PCR amplification of a portion of the 23S ribosomal RNA gene; and (3) When a 194-bp band or a 475-bp band was detected using UV transillumination after gel electrophoresis, the amplified DNA products were determined to have the A2142G or A2143G point mutation.

Eradication regimens for *Helicobacter pylori*

The PAC regimen consisted of 30 mg lansoprazole + 500 mg CAM + 1000 mg AMX, administered twice daily for 7 or 14 d. PAC regimen was administered for 7 d or 14 d randomly. The EBQT regimen consisted of 30 mg lansoprazole twice daily + 500 mg MYZ twice daily + 300 mg bismuthate four times daily + 500 mg tetracycline four times daily for 14 d.

Outcome measures, efficacy, safety profile, and compliance

The eradication success rate, patient-reported side effect rate, and compliance with *H. pylori* eradication were evaluated and compared between the groups by intention-to-treat (ITT) and per-protocol (PP) analyses. Efficacy, as measured by the eradication success rates of the two eradication regimens, was tested at least 4 wk after treatment using the ¹³C-urea breath test (UBT; UBTkit; Otsuka Pharmaceutical Co. Ltd., Tokyo, Japan). Each patient was orally administered with 100 mg ¹³C-urea. A cutoff of delta ¹³CO₂ < 2.5‰ was used to confirm eradication in this study. To avoid a false result on the UBT test, all patients discontinued any PPI, H₂ blocker, or antibiotic use at least 4 wk before the UBT.

To analyze treatment-related side effects, patient-reported complications and compliance were recorded at the end of the visit. Patients were informed of the type of side effects of the eradication treatment at the time of prescription. Treatment-related complications included any case of opportunistic infections, abnormal taste, loss of appetite, dry mouth, sore or dry throat, nausea and vomiting, bloating, belching, abdominal pain, dyspepsia, or general weakness. Each patient evaluated

their symptoms on a scale of mild, moderate, or severe. Patient compliance with treatment was defined as consumption of more than 90% of the prescribed therapy.

Statistical analysis

The *H. pylori* eradication rate was depicted by ITT and PP analyses. Patients lost to follow-up or those with poor compliance were excluded from the PP analysis. Categorical variables were analyzed as median and interquartile range by the χ^2 test. Continuous variables are given as the mean \pm SD, and were compared between groups using Student's *t*-test. A *P*-value < 0.05 was considered significant. The Statistical Package for the Social Sciences (SPSS) software version 20.0 (IBM Corp., Armonk, NY, United States) was used for statistical analyses.

RESULTS

Characteristics of the study population

From May 2016 to September 2018, a total of 154 patients with *H. pylori* infection were enrolled and assigned to receive either TR ($n = 50$) or EBQT ($n = 104$) (Table 1). The mean age of patients in the TR and EBQT groups was 58.3 ± 13.9 years and 57.4 ± 11.6 years, respectively. The most common reason for eradication was peptic ulcer disease ($n = 15$, 48.4%) in the TR group, and chronic atrophic gastritis with intestinal metaplasia in the EBQT group ($n = 71$, 68.3%) (Table 2). Among the subjects, four with poor compliance in the EBQT group were excluded from ITT analysis for *H. pylori* eradication (Figure 1). All the recruited patients received complete follow-up (Figure 1).

Eradication rate

The TR and EBQT groups had comparable results in both ITT analysis (96.0% vs 94.2%; $P = 0.6$) and PP analysis (96.0% vs 95.0%; $P = 0.8$). It was showed that *H. pylori* infection was cured in 96.0% (48/50) of the patients receiving TR and 95.0% (95/100) of those receiving EBQT treatment. Only two patients failed to eradication in the TR group. One patient receiving the PAC regimen had no mutation detected by DPO-PCR, and another patient showed an A2143G mutation on DPO-PCR.

Treatment-related adverse events

In the ITT analysis involving a total of 154 *H. pylori* infected patients, 12.0% (6/50) of the TR recipients and 43.7% (45/104) of those treated with EBQT reported at least one adverse event during eradication therapy. In the tailored group, 36 patients were treated with the PAC regimen and 14 treated with the BQT regimen; no patients treated with the PAC regimen (0/36) reported adverse events and two patients treated with the BQT regimen (2/14) had eradication-related adverse events. The EBQT group exhibited a statistically significantly higher frequency of overall adverse events than the TR group (43.7% vs 12.0%; $P \leq 0.01$) (Table 3). None of the patients discontinued treatment because of adverse events.

Treatment compliance

Four patients (all in EBQT group) took less than 80% of the assigned tablets. The EBQT group showed a lower compliance rate, but there was no statistical significance (100.0% vs 96.2%, $P = 0.2$).

DISCUSSION

In this open-label, comparative study, we compared the efficacy and safety profiles between the TR strategy, based on the presence of a 23S ribosomal RNA point mutation ($n = 50$), and the EBQT strategy ($n = 100$) as first-line eradication strategies for *H. pylori* infection in Korea. The efficacy of TR was similar to that of EBQT (96.0% vs 95.7%, $P = 0.9$), and the side effect profile of TR was significantly better than that of EBQT (12% vs 43.0%, $P < 0.001$). Given that the eradication rate of the empirical triple regimen (PPI + AMX + CAM) has decreased to less than 70% in Korea, the DPO-PCR-based TR may be an effective first-line eradication therapy with fewer treatment-related side effects compared to EBQT.

To our knowledge, this is the first study to make a head-to-head comparison of the efficacy and safety of the TR and EBQT regimens. In this study, we did not consider PPI-based triple therapy as an eradication option, because the CAM resistance rate has surpassed 15% in Korea, and the efficacy of empirical triple therapy is minimal. The latest version of the Korean Clinical Practice Guidelines for *H. pylori* recommend

Table 1 Baseline characteristics of the study population

	Tailored therapy using DPO-PCR (<i>n</i> = 50)	Empirical bismuth-based quadruple therapy (<i>n</i> = 104)	<i>P</i> value
Age, mean ± SD (yr)	58.3 ± 13.9	57.4 ± 11.6	0.3
Men, <i>n</i> (%)	30 (60.0)	56 (53.8)	0.5
Smoking, <i>n</i> (%)	13 (26.0)	17 (16.3)	0.2
Drinking, <i>n</i> (%)	16 (32.0)	34 (32.7)	0.8
Comorbidity			
Hypertension, <i>n</i> (%)	11 (22.0)	31 (29.8)	0.4
Diabetes mellitus, <i>n</i> (%)	11 (22.0)	17 (16.3)	0.5
Cardiovascular disease, <i>n</i> (%)	2 (4.0)	6 (5.8)	0.6
Reasons for eradication, <i>n</i> (%)			
Peptic ulcer disease	37 (64.0)	28 (26.9)	0.002
Post ESD due to EGC	8 (16.0)	3 (2.9)	0.003
Post ESD due to adenoma	5 (10.0)	2 (1.9)	0.024
MALToma	2 (4.0)	0 (0.0)	0.04
Chronic atrophic gastritis with intestinal metaplasia	2 (4.0)	71 (68.3)	< 0.001
Nodular gastritis	3 (6.0)	0 (0.0)	
Clarithromycin resistance diagnosed by DPO-PCR, <i>n</i> (%)		Non available	
No	37 (74.0)		
A2142G positive	1 (2.0)		
A2143G positive	12 (24.0)		

DPO-PCR: Dual priming oligonucleotide polymerase chain reaction; ESD: Endoscopic submucosal dissection; EGC: Early gastric cancer; MALToma: Mucosa associated lymphoid tissue lymphoma.

either triple therapy with a PPI, AMX, and CAM, or a bismuth-based quadruple regimen if CAM resistance is suspected. In addition, several reports suggest that 9.6% of the strains in Korea have dual resistance to CAM and MTZ^[20,22,23]; thus, it may be prudent to avoid choosing an empirical conventional triple regimen as a first-line eradication strategy. Therefore, we did not choose the triple regimen in this study.

Both the Maastricht V/Florence and Korean guidelines recommend bismuth-based quadruple therapy as the policy for failed first-line therapy, or even as an option for first-line therapy. However, several reports have indicated treatment-related side effects of bismuth-based quadruple therapy, which may directly lead to poor patient compliance. Given that treatment-related side effects might lead to treatment failure, and imperfect eradication is closely associated with increased antibiotic resistance, treatment-related side effects are important factors when considering *H. pylori* treatment. A multicenter study from Italy, where CAM resistance rates are above 15%, reported that 46.6% of patients who received bismuth-based quadruple therapy complained of at least one side effect, including nausea, diarrhea, and vomiting, among 209 patients^[7], which was similar to the rate observed in the present study. Daniela *et al* conducted a randomized controlled trial in Israel, where CAM resistance rates are increasing, and the patients who took the bismuth-containing regimen reported significantly more treatment-related complications (84.0%), such as gastrointestinal discomfort, with less compliance^[24]. Although there has been a wide range of complication rates for bismuth-containing quadruple therapy, the complication rates are not negligible, which can lead to poor compliance.

In addition to the treatment-related complications of the bismuth-based quadruple regimen, too many antibiotics have been used to eradicate *H. pylori*. Because the empirical bismuth-based quadruple regimen includes MTZ and tetracycline, and inappropriate antibiotic use leads to antibiotic resistance, antibiotics should be prescribed more carefully in Korea considering the high CAM (>5%) and MTZ (>30%) resistance rates. As *H. pylori* culture and antibiotic sensitivity testing are not always available in a clinical setting, DPO-PCR-based tailored therapy is a realistic option for eradication in a region with increasing antibiotic resistance.

Several studies have indicated favorable outcomes of DPO-PCR-based tailored therapies in line with our results, even though there are no published comparisons between tailored therapy and bismuth-based quadruple therapy^[15,16]. Zhou *et al*^[25]

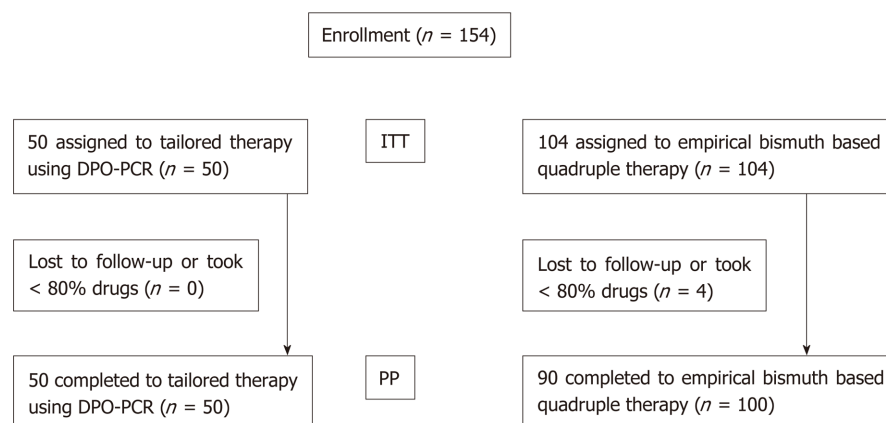


Figure 1 Flow chart. DPO-PCR: Dual priming oligonucleotide polymerase chain reaction; ITT: Intention-to-treat analysis; PP: Per-protocol analysis.

reported that tailored therapy achieved a significantly higher eradication rate (88.7% *vs* 78.3%) and fewer side effects (22.0% *vs* 31.7%) than a concomitant therapy. Park *et al*^[26] reported that personalized tailored therapy based on 23S rRNA genotypes can increase eradication success rates in patients with *H. pylori* infection compared to empirical CAM-based triple therapy, as the 2143G point mutation in the 23S rRNA of *H. pylori* was found to be an independent risk factor for eradication failure in CAM-based triple therapy. Furthermore, Cho *et al*^[27] reported that a tailored *H. pylori* eradication strategy based on the presence of a 23S ribosomal RNA point mutation that causes CAM resistance in patients with *H. pylori* infection is more cost-effective than empirical treatment. Kim *et al*^[9] also conducted an economic modeling study comparing TR based on DPO-PCR and empirical treatment.

Even though there have been limited reports in which the TR *vs* EBQT regimens were compared in terms of cost-effectiveness, the cost problem of the TR regimen should be evaluated as compared to EBQT design for the first-line treatment in *H. pylori* eradication. Cho *et al*^[27] reported that a tailored *H. pylori* eradication strategy based on the presence of a 23S ribosomal RNA point mutation that causes CAM resistance in patients with *H. pylori* infection is more cost-effective than empirical treatment. In that study, different from ours, the researchers chose the PAC regimen as the empirical treatment^[27]. Cho *et al*^[27] demonstrated that the average costs per patient for tailored therapy were \$307.37, and compared with triple therapy, the incremental cost-effectiveness ratio of tailored therapy was \$3.96 per patient for first-line treatments. Since the failure rate of the PAC regimen for *H. pylori* eradication has been increasing in Korea, the overall medical costs for the PAC regimen might be higher than those of EBQT designs. The medical cost issue should be further evaluated.

Apart from medical cost problem of the TR regimen, given issues on increased prevalence of drug resistance of *H. pylori* worldwide, tailored approaches in treating *H. pylori* infection should be considered further. The possible reasons for treatment failure in the TR group are as follows^[28,29]. First, although *H. pylori* has traditionally been regarded as a homogenous organism, there is increasing evidence that populations of *H. pylori* in humans show wide diversity^[29]. The quasi-species development of *H. pylori* in a single host might result in treatment failure even after a tailored eradication strategy based on the presence of a 23S ribosomal RNA point mutation^[28]. Second, a DPO-PCR-based evaluation is limited to detecting mutations of A2142G and A2143G in 23S rRNA, and other mutations, such as the A2144G or A2142C mutation of *H. pylori*, cannot be detected^[20,30].

This study had several limitations. First, because of the relatively small sample size, the results of this study should be interpreted cautiously. A further larger sample-sized, randomized trial should be conducted to verify our results. Second, as this study was conducted at the GMC, a tertiary center in Korea, it may have been subject to selection bias. Third, we did not culture the *H. pylori* from enrolled patients for antibiotic sensitivity testing, but DPO-PCR was performed for CAM. In conclusion, this study showed that TR is a first-line eradication regimen with non-inferior efficacy and a favorable safety profile compared to bismuth-based quadruple therapy. A future eradication regimen could potentially be designed based on these results for areas where CAM resistance rates are increasing.

Table 2 *Helicobacter pylori* eradication success rates and complication rates, *n* (%)

Eradication rate	Tailored therapy using DPO-PCR (<i>n</i> = 50)	Empirical bismuth-based quadruple therapy (<i>n</i> = 104)	<i>P</i> value
Intention-to-treat analysis	48 (96.0)	98 (94.2)	0.6
Per-protocol analysis	48/50 (96.0)	95/100 (95.0)	0.8

DPO-PCR: Dual priming oligonucleotide polymerase chain reaction.

Table 3 Eradication-related adverse events, *n* (%)

	Tailored therapy using DPO-PCR (<i>n</i> = 50)	Empirical bismuth-based quadruple therapy (<i>n</i> = 104)	<i>P</i> value
Eradication-related side effects			< 0.001
No	44 (88.0)	59 (56.7)	
Yes	6 (12.0)	45 (43.7)	
Abdominal discomfort	0 (0.0)	1 (1.0)	
Nausea/vomiting	3 (6.0)	12 (11.5)	
Diarrhea/loose stool	0 (0.0)	12 (11.5)	
Dyspepsia	2 (4.0)	10 (9.6)	
General weakness	1 (2.0)	6 (5.8)	
Taste disturbance	0 (0.0)	4 (3.8)	
Treatment compliances	50 (100.0)	100 (96.2)	0.2

DPO-PCR: Dual priming oligonucleotide polymerase chain reaction.

ARTICLE HIGHLIGHTS

Research background

As the resistance rate for *Helicobacter pylori* (*H. pylori*) eradication regimen has been increased worldwide and also in Korea, the strategy to reduce the chance of *H. pylori* resistance rate is an unmet need.

Research motivation

In general, antibiotic resistance has been attributed to the improper use of antibiotics. In this regard, tailored regimen has recently been introduced for *H. pylori* eradication. However, few studies have compared the efficacy and safety profile of a TR strategy based on the presence of a 23S ribosomal RNA point mutation with those of EBQT as first-line eradication therapy for *H. pylori* infection in Korean patients.

Research objectives

To compare the efficacy and safety profile of a TR strategy *vs* the EBQT regimen as first-line eradication therapy for *H. pylori* in Korean patients.

Research methods

We prospectively enrolled patients over 18 years of age with *H. pylori* infection from May 2016 to September 2018 at GMC, conducted an open-label, and comparative study, and retrospectively reviewed the data. *H. pylori*-positive patients diagnosed by the rapid urease test, Giemsa staining, or dual priming oligonucleotide polymerase chain reaction (DPO-PCR) were enrolled. Patients with *H. pylori* infection received either a TR regimen or the EBQT regimen. In the tailored therapy group that underwent DPO-PCR testing, patients with A2142G and/or A2143G point mutations were treated with a bismuth-containing quadruple regimen. The eradication rate, patient-reported side effect rate, and *H. pylori* eradication success rate were evaluated and compared between the groups.

Research results

A total of 150 patients were assigned to the TR (*n* = 50) or EBQT group (*n* = 100). The first-line eradication rate of *H. pylori* did not differ between the groups (96.0% *vs* 95.7%, *P* = 0.9). The rate of eradication-related side effects for TR was 12.0%, which differed significantly from that of EBQT (43.0%) for first-line treatment (*P* < 0.001).

Research conclusions

DPO-PCR-based TR for *H. pylori* eradication may be equally efficacious, with less treatment-related complications, compared to EBQT as first line eradication regimen in Korea, where

clarithromycin (CAM) resistance is high.

Research perspectives

Our study showed that TR is a first-line eradication regimen with non-inferior efficacy and a favorable safety profile compared to bismuth-based quadruple therapy. A future eradication regimen could potentially be designed based on these results for areas where CAM resistance rates are increasing.

REFERENCES

- 1 **Tsukamoto T**, Nakagawa M, Kiriya Y, Toyoda T, Cao X. Prevention of Gastric Cancer: Eradication of *Helicobacter Pylori* and Beyond. *Int J Mol Sci* 2017; **18** [PMID: 28771198 DOI: 10.3390/ijms18081699]
- 2 **Wang F**, Meng W, Wang B, Qiao L. *Helicobacter pylori*-induced gastric inflammation and gastric cancer. *Cancer Lett* 2014; **345**: 196-202 [PMID: 23981572 DOI: 10.1016/j.canlet.2013.08.016]
- 3 **Jonaitis L**, Pellicano R, Kupcinskas L. *Helicobacter pylori* and nonmalignant upper gastrointestinal diseases. *Helicobacter* 2018; **23** Suppl 1: e12522 [PMID: 30203583 DOI: 10.1111/hel.12522]
- 4 **Bravo D**, Hoare A, Soto C, Valenzuela MA, Quest AF. *Helicobacter pylori* in human health and disease: Mechanisms for local gastric and systemic effects. *World J Gastroenterol* 2018; **24**: 3071-3089 [PMID: 30065554 DOI: 10.3748/wjg.v24.i28.3071]
- 5 **Lee YC**, Chiang TH, Chou CK, Tu YK, Liao WC, Wu MS, Graham DY. Association Between *Helicobacter pylori* Eradication and Gastric Cancer Incidence: A Systematic Review and Meta-analysis. *Gastroenterology* 2016; **150**: 1113-1124.e5 [PMID: 26836587 DOI: 10.1053/j.gastro.2016.01.028]
- 6 **Jung YS**, Park CH, Park JH, Nam E, Lee HL. Efficacy of *Helicobacter pylori* eradication therapies in Korea: A systematic review and network meta-analysis. *Helicobacter* 2017; **22** [PMID: 28425141 DOI: 10.1111/hel.12389]
- 7 **Zullo A**, De Francesco V, Bellesia A, Vassallo R, D'Angelo A, Scaccianoce G, Sacco R, Bresci G, Eramo A, Tanzilli A, Ridola L, Alvaro D, Londoni C, Brambilla G, Manta R, Di Ciaula A, Portincasa P. Bismuth-based quadruple therapy following *H. pylori* eradication failures: a multicenter study in clinical practice. *J Gastrointest Liver Dis* 2017; **26**: 225-229 [PMID: 28922433 DOI: 10.15403/jgld.2014.1121.263.zul]
- 8 **Malfertheiner P**, Megraud F, O'Morain CA, Gisbert JP, Kuipers EJ, Axon AT, Bazzoli F, Gasbarrini A, Atherton J, Graham DY, Hunt R, Moayyedi P, Rokkas T, Rugge M, Selgrad M, Suerbaum S, Sugano K, El-Omar EM; European *Helicobacter* and Microbiota Study Group and Consensus panel. Management of *Helicobacter pylori* infection-the Maastricht V/Florence Consensus Report. *Gut* 2017; **66**: 6-30 [PMID: 27707777 DOI: 10.1136/gutjnl-2016-312288]
- 9 **Kim SG**, Jung HK, Lee HL, Jang JY, Lee H, Kim CG, Shin WG, Shin ES, Lee YC; Korean College of *Helicobacter* and Upper Gastrointestinal Research. Guidelines for the diagnosis and treatment of *Helicobacter pylori* infection in Korea, 2013 revised edition. *J Gastroenterol Hepatol* 2014; **29**: 1371-1386 [PMID: 24758240 DOI: 10.1111/jgh.12607]
- 10 **Lee JY**, Kim N, Park KS, Kim HJ, Park SM, Baik GH, Shim KN, Oh JH, Choi SC, Kim SE, Kim WH, Park SY, Kim GH, Lee BE, Jo Y, Hong SJ. Comparison of sequential therapy and amoxicillin/tetracycline containing bismuth quadruple therapy for the first-line eradication of *Helicobacter pylori*: a prospective, multi-center, randomized clinical trial. *BMC Gastroenterol* 2016; **16**: 79 [PMID: 27460100 DOI: 10.1186/s12876-016-0490-8]
- 11 **Macías-García F**, Bastón-Rey I, de la Iglesia-García D, Calviño-Suárez C, Nieto-García L, Domínguez-Muñoz JE. Bismuth-containing quadruple therapy versus concomitant quadruple therapy as first-line treatment for *Helicobacter Pylori* infection in an area of high resistance to clarithromycin: A prospective, cross-sectional, comparative, open trial. *Helicobacter* 2019; **24**: e12546 [PMID: 30346636 DOI: 10.1111/hel.12546]
- 12 **Ko SW**, Kim YJ, Chung WC, Lee SJ. Bismuth supplements as the first-line regimen for *Helicobacter pylori* eradication therapy: Systemic review and meta-analysis. *Helicobacter* 2019; **24**: e12565 [PMID: 30698318 DOI: 10.1111/hel.12565]
- 13 **Lin TF**, Hsu PI. Second-line rescue treatment of *Helicobacter pylori* infection: Where are we now? *World J Gastroenterol* 2018; **24**: 4548-4553 [PMID: 30386104 DOI: 10.3748/wjg.v24.i40.4548]
- 14 **Park CG**, Kim S, Lee EJ, Jeon HS, Han S. Clinical relevance of point mutations in the 23S rRNA gene in *Helicobacter pylori* eradication: A prospective, observational study. *Medicine (Baltimore)* 2018; **97**: e11835 [PMID: 30113472 DOI: 10.1097/MD.00000000000011835]
- 15 **Liu Q**, Qi D, Kang J, Jin Y, Liu W, Gao W, Hou P, Lu J. Efficacy of real-time PCR-based detection of *Helicobacter pylori* infection and genotypic resistance-guided quadruple therapy as the first-line treatment for functional dyspepsia with *Helicobacter pylori* infection. *Eur J Gastroenterol Hepatol* 2015; **27**: 221-225 [PMID: 25629566 DOI: 10.1097/MEG.0000000000000186]
- 16 **Lee JW**, Kim N, Nam RH, Lee SM, Kwon YH, Sohn SD, Kim JM, Lee DH, Jung HC. Favorable outcomes of culture-based *Helicobacter pylori* eradication therapy in a region with high antimicrobial resistance. *Helicobacter* 2019; **24**: e12561 [PMID: 30632237 DOI: 10.1111/hel.12561]
- 17 **Peng X**, Song Z, He L, Lin S, Gong Y, Sun L, Zhao F, Gu Y, You Y, Zhou L, Zhang J. Gastric Juice-Based Real-Time PCR for Tailored *Helicobacter Pylori* Treatment: A Practical Approach. *Int J Med Sci* 2017; **14**: 595-601 [PMID: 28638276 DOI: 10.7150/ijms.18996]
- 18 **Boyanova L**, Markovska R, Yordanov D, Gergova G, Mitov I. Clarithromycin Resistance Mutations in *Helicobacter pylori* in Association with Virulence Factors and Antibiotic Susceptibility of the Strains. *Microb Drug Resist* 2016; **22**: 227-232 [PMID: 26618567 DOI: 10.1089/mdr.2015.0199]
- 19 **Lehours P**, Siffré E, Mégraud F. DPO multiplex PCR as an alternative to culture and susceptibility testing to detect *Helicobacter pylori* and its resistance to clarithromycin. *BMC Gastroenterol* 2011; **11**: 112 [PMID: 22004003 DOI: 10.1186/1471-230X-11-112]
- 20 **Chung WC**, Jung SH, Oh JH, Kim TH, Cheung DY, Kim BW, Kim SS, Kim JI, Sin EY. Dual-priming oligonucleotide-based multiplex PCR using tissue samples in rapid urease test in the detection of *Helicobacter pylori* infection. *World J Gastroenterol* 2014; **20**: 6547-6553 [PMID: 24914376 DOI: 10.3748/wjg.v20.i21.6547]
- 21 **Dong F**, Ji D, Huang R, Zhang F, Huang Y, Xiang P, Kong M, Nan L, Zeng X, Wu Y, Bao Z. Multiple Genetic Analysis System-Based Antibiotic Susceptibility Testing in *Helicobacter pylori* and High

- Eradication Rate With Phenotypic Resistance-Guided Quadruple Therapy. *Medicine (Baltimore)* 2015; **94**: e2056 [PMID: 26632710 DOI: 10.1097/MD.0000000000002056]
- 22 **Chung JW**, Jung YK, Kim YJ, Kwon KA, Kim JH, Lee JJ, Lee SM, Hahm KB, Lee SM, Jeong JY, Yun SC. Ten-day sequential versus triple therapy for *Helicobacter pylori* eradication: a prospective, open-label, randomized trial. *J Gastroenterol Hepatol* 2012; **27**: 1675-1680 [PMID: 22849546 DOI: 10.1111/j.1440-1746.2012.07249.x]
 - 23 **Chung JW**, Kim SY, Park HJ, Chung CS, Lee HW, Lee SM, Kim I, Pak JH, Lee GH, Jeong JY. *In Vitro* Activity of Diphenyleneiodonium toward Multidrug-Resistant *Helicobacter pylori* Strains. *Gut Liver* 2017; **11**: 648-654 [PMID: 28750485 DOI: 10.5009/gnl16503]
 - 24 **Munteanu D**, Etzion O, Ben-Yakov G, Halperin D, Eidelman L, Schwartz D, Novack V, Abufreha N, Krugliak P, Rozenthal A, Gaspar N, Moshkalo A, Dizingof V, Fich A. Efficacy and safety of sequential versus quadruple therapy as second-line treatment for *Helicobacter pylori* infection-A randomized controlled trial. *PLoS One* 2017; **12**: e0183302 [PMID: 28957341 DOI: 10.1371/journal.pone.0183302]
 - 25 **Zhou L**, Zhang J, Song Z, He L, Li Y, Qian J, Bai P, Xue Y, Wang Y, Lin S. Tailored versus Triple plus Bismuth or Concomitant Therapy as Initial *Helicobacter pylori* Treatment: A Randomized Trial. *Helicobacter* 2016; **21**: 91-99 [PMID: 26104022 DOI: 10.1111/hel.12242]
 - 26 **Park CS**, Lee SM, Park CH, Koh HR, Jun CH, Park SY, Lee WS, Joo YE, Kim HS, Choi SK, Rew JS. Pretreatment antimicrobial susceptibility-guided vs. clarithromycin-based triple therapy for *Helicobacter pylori* eradication in a region with high rates of multiple drug resistance. *Am J Gastroenterol* 2014; **109**: 1595-1602 [PMID: 25091062 DOI: 10.1038/ajg.2014.222]
 - 27 **Cho JH**, Jeon SR, Kim HG, Jin SY, Park S. Cost-effectiveness of a tailored *Helicobacter pylori* eradication strategy based on the presence of a 23S ribosomal RNA point mutation that causes clarithromycin resistance in Korean patients. *J Gastroenterol Hepatol* 2019; **34**: 700-706 [PMID: 30011083 DOI: 10.1111/jgh.14383]
 - 28 **Farzi N**, Malekian T, Alebouyeh M, Vaziri F, Zali MR. Genotype Diversity and Quasispecies Development of *Helicobacter pylori* in a Single Host. *Jpn J Infect Dis* 2015; **68**: 176-180 [PMID: 25672355 DOI: 10.7883/yoken.JJID.2014.165]
 - 29 **Blaser MJ**. Heterogeneity of *Helicobacter pylori*. *Eur J Gastroenterol Hepatol* 2012; **9** Suppl 1: S3-S6; discussion S6-S7 [PMID: 22498905 DOI: 10.1097/00042737-201204001-00002]
 - 30 **Jung DH**, Kim JH, Jeong SJ, Park SY, Kang IM, Lee KH, Song YG. Peptide Nucleic Acid Probe-Based Analysis as a New Detection Method for Clarithromycin Resistance in *Helicobacter pylori*. *Gut Liver* 2018; **12**: 641-647 [PMID: 30037168 DOI: 10.5009/gnl18111]



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