The study of the oipA and dupA genes in Helicobacter pylori strains and their relationship with different gastroduodenal diseases

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ABSTRACT

Aim: The purpose of this investigation was to determine the oipA and dupA genes of Helicobacter pylori isolates from west of Iran; Chaharmahalo Bakhtiyari region and find their relationship with the severity of the gastroduodenal diseases.

Background: Helicobacter pylori is an organism responsible for many gastroduodenal diseases. Many studies suggest that genetic diversity in H. pylori virulence factors such as oipA and dupA genes is high among isolates of different geographic regions and may cause more severe diseases.

Patients and methods: In this cross-sectional study, gastric biopsy specimens were taken from 150 patients suffering from gastroduodenal diseases. The presence of ureC, dupA and oipA genes was tested by polymerase chain reaction (PCR).

Results: Overall, 123 (82%) H. pylori strains were isolated from 150 specimens. dupA gene was detected in 41 (33.33%) H.pylori-positive specimens. There was a reverse correlation between this gene and gastric cancer. The oipA gene was found in 88 (71.54%) samples and statistically there was no association between this gene and gastric disorders. As statistical analyses revealed, the presence of the dupA was more common in isolates with the oipA negative.

Conclusion: Based on our findings, the presence of dupA gene can be considered as a marker for the onset of severe diseases. However, the oipA gene cannot be regarded for prediction of gastroenterology diseases. Meanwhile, extended molecular epidemiology researches in other populations are recommended.

Keywords: Helicobacter pylori, oipA, dupA, PCR, Gastric disorders.

Introduction

Helicobacter pylori is a major cause of chronic gastritis and involved in the pathogenesis of several diseases like gastric and duodenal ulcer, gastric adenocarcinoma, and mucosa-associated lymphoid tissue lymphoma (1-3). This bacterium has several virulence factors which are generally classified into three categories: The first group belongs to strain-specific genes, such as cag pathogenicity island (PAI) and Plasticity Island.
genes (e.g. *jhp0947* and *dupA* genes) which do not exist in all *H. pylori* strains. The second group consists of phase-variable genes whose gene status can be changed during growth or under different conditions. Six genes encoding outer-membrane proteins (*babB*, *oipA*, *hopZ sabA*, *sabB* and *babC*) are thought to undergo phase variation. The last group consists of genes with variable genotypes or structures depending on the strain. For instance, specific *vacA* genotypes containing different mosaic combinations of signal regions (s), middle region (m) and intermediate region (i) allelic types have been associated with different clinical outcomes (4). Reports on the clinical predictive value of putative virulence factor status and disease outcomes are controversial based on different geographic regions (5-8). On the other hand, these factors are not independent and are often closely linked (e.g., the *cag* PAI, *vacA* s1, and the *babA2* gene) making it difficult to classify which factor(s) has the most important predictor role in diseases severity and clinical manifestations (9). Several studies have provided new insights into the role of several putative virulence factors of *H. pylori* in gastroduodenal pathogenesis. Recently, the duodenal ulcer-promoting gene (*dupA*), which encompassed both *jhp0917* and *jhp0918* and located in the plasticity region of *H. pylori* genome, was identified (10). Interestingly, the *dupA* gene is homologous to *virB4*, a gene encoding a component protein of the type IV secretion system (TFSS) in *Agrobacterium tumefaciens* (3). The *jhp0917* and *jhp0918*, were examined by Lu et al. in 2005 and illustrated as a risk marker for prediction of duodenal ulcer disease and a protective factor against gastric cancer in strains isolated from Japan, Korea and Colombia (11). This continuous gene as a virulence marker was found to be more prevalent in patients with duodenal ulcer while was associated with a reduced risk for development of gastric atrophy and cancer in these populations (12, 13). In contrast, the *dupA* genotyping in some areas showed no association of this gene with duodenal ulcer, but suggested an association with gastric cancer (10, 14).

The *H. pylori* outer inflammatory protein, OipA, is an important virulence factor which is associated with clinically important presentation of peptic ulcer, such as enhanced interleukin-8 secretion and increased inflammation (15). *H. pylori* contain either a functional or non-functional *oipA* gene. The functional status is regulated by the slipped strand repair mechanism based on the number of CT dinucleotide repeats in the 5' region of the gene (9).

Considering the high prevalence of *H. pylori* infection in Iranian population, there are several reports about common virulence markers such as *vacA* and *cagA*, however there is very limited documents about *dupA* and *oipA*. The aim of our study was to assess the distribution of *dupA* and *oipA* genes in *H. pylori* strains isolated from patients with gastrointestinal disorders and to determine whether, these genes are associated with different clinical outcomes.

**Patients and Methods**

**Sample**

Sampling was performed over a year (March 2010 to February 2011) from patients with gastroduodenal diseases referred to endoscopy centre of Hagar hospital of Shahrekord city in the west of Iran. Prior to sampling the questionnaire including medical history and demographic data were recorded for each patient. Informed consent form, declaring their willingness for the application of their anonymous data for research purpose was obtained from all studied patients prior to endoscopy. The protocol was approved by the ethical committee of Shahrekord University of Medical Science. Four gastric punch biopsy specimens from antrum of the stomach of each patient were collected; two for histopathology study, one for RUT test and the other for PCR.
Rapid Urease Test (RUT)

One piece of each specimen was examined by Rapid Urease Test (RUT) for detection of *H. pylori*. Rapid urease test was performed with a Gastro urease kit (Bahar-Afshan Co, Tehran, Iran) according to manufacturer’s instruction.

Preparation of genomic DNA and polymerase chain reaction: A second piece from positive samples in RUT was used in PCR. DNA was extracted from biopsy specimens using a Genomic DNA purification kit (Qiagen, Hilden, Germany) according to manufacturer’s recommendations. The 16S rRNA gene was amplified to confirm the presence of the isolated *H. pylori* strains. According to table 1, HP-1 and HP-2 primers designed and verified previously for this aim (16, 17). For analyses of the presence of target genes (*dupA* and *oipA*), *H. pylori* DNA was amplified using specific oligonucleotide primers (Table 1). Primers of *jhp0917* and *jhp0918* yielded fragments of approximately 307 and 276 bp, respectively. The primers of the *oipA* gene yielded a fragment of 401 bp. DNA samples from *H. pylori* (D0008; Genekam, Germany) were used as a positive control of 16S rRNA, *dupA* and *oipA* genes, and sterile distilled water was used as a negative control. All PCR mixtures were prepared in a volume of 25 µL containing 1X PCR buffer, 0.4 µM of each primer, 0.3 U Taq DNA polymerase (CinnaGen Co., Tehran, Iran) and 300 ng DNA sample. The mixture placed in a thermocycler (Eppendorf Mastercycler 5330; Eppendorf-Nethel-Hinz GmbH, Hamburg, Germany), and PCR products were visualized by electrophoresis in 1.5% agarose gel, stained with ethidium bromide, and examined under ultraviolet illumination.

Data analysis

The data were analyzed using SPSS software (Version 17, SPSS Inc, USA) and p value was calculated using Chi-square and Fisher's exact tests to find any significant relationship. *P* values less than 0.05 were considered statistically significant.

Histopathology

During endoscopy two biopsy specimens were taken from the antrum for histological evaluation. These specimens were fixed in 10% buffered formalin, embedded in paraffin, cut into sequential 4µm sections and stained with hematoxylin and eosin (H&E) and modified Giemsa stain. Multiple high-powered fields were examined by two pathologists blinded to the characteristics of *H.pylori* strains.

Results

150 patients with mean age of 46 ± 17 years, including 71 (47%) men and 79 (53%) women, were studied. Based on RUTs, 131 (87%) of patients were *H.pylori* positive while according to PCR assays 123 (82%) specimens were confirmed to be *H.pylori* positive. The patients were

### Table 1. Primers used for PCR analysis of *ureC*, *dupA* and *oipA* genes

| Gene          | Primer | Primer sequence (5’-3’) | Size (bp) of PCR product | Reference |
|---------------|--------|-------------------------|--------------------------|-----------|
| 16S rRNA      | HP-1   | CTGGAGAGACTAAGCCCTCC    | 109                      | 16        |
|               | HP-2   | ATTACTGACGCTTATTGTCG    |                         |           |
| *jhp0917* (virB4) | JHP917 (+) | TGGTTTCTACTGACAGAGGC   | 307                      | 11        |
|               | JHP917 (_) | AACACGCTGACAGACAATCTCCC |                         |           |
| *jhp0918* (virB4) | JHP918 (+) | CCTATATGCCTAAGCGAGGCTC | 276                      | 11        |
|               | JHP918 (_) | AAGGTGAAGCGTTTGTAAACG  |                         |           |
| *oipA*        | HPO638F | GTTTTTTGATGCTGATGATTT  | 401                      | 23        |
|               | HPO638R | GTGCATCTTTATGGCTTT     |                         |           |
classified at the time of endoscopy and histopathology as having gastritis ulcers (n=18), Duodenal ulcer (n=33), Gastric cancer (n=2), gastritis (n=120), and duodenitis (n=6). It should be noted that (63%) of patients had several diseases together. Individuals had some clinical symptoms such as pain (n=112), vomiting (n=43), inappetence (n=25), Acid reflux (n=41), and flatulence (n=39). Demographic factors such as gender, education, occupation and gastric drug usage, did not show any statistical correlation with H. pylori infection and clinical outcomes (P>0.05). But smoking (P<0.0001) and age (P=0.02) were significantly associated with H. pylori infection.

In this study, dupA gene was detected in 41 (33.33%) specimens. As table 2 shows, there was no significant relationship between dupA status and duodenal ulcer disease (P=0.25). However, there was a converse relationship between dupA-negative strains and gastric cancer disease (P=0.02). There was a considerable correlation between the presence of this gene and patient’s age (P=0.007), smoking (P=0.04) and individuals who suffer flatulence (P=0.03). The oipA genotype was detected in 88 (71.54%) of H. pylori positive samples. This gene was in relation with the age groups of patients (P=0.007) and was more common in patients with gastritis rather than other groups (P=0.001). There was a close relationship between infection with oipA positive H. pylori and the presence of vomiting (P=0.009) and stomachache (P=0.03) regardless of clinical outcomes. As statistical analyses revealed, the presence of the dupA were more common in isolates with the oipA negative (P<0.0001).

### Discussion

H. pylori infection is very common worldwide. It is estimated that more than 50% of the world’s population are infected with H. pylori (14). The rapid changes in the epidemiology of different clinical outcomes caused by H. pylori suggest an interaction between an environmental factor, host and microbes that leads to a change in prevalence of strains differing in virulence (1, 6). Several studies have been evaluated the association between different virulence factors of H. pylori and clinical manifestations in Iranian population. There is limited information about dupA and oipA to define predictive value of virulence marker for gastric disorders. In the current survey, we have examined two H. pylori virulence factors; one is located in plasticity region (dupA) and the other is a phase variable gene (oipA). We also evaluated their relationship with different gastric disorders in the west of Iran.

The prevalence of H. pylori differs significantly both between and within countries, with high rates of infection being associated with low socioeconomic status and high densities of living (18, 19). For instance, in Japan, South America, Turkey and Pakistan, the prevalence is more than 80%, while in Scandinavia and England, the prevalence is between 20% and 40% (6, 7). The prevalence of this bacterium in Iran is 60-90%, indicating Iran is a high risk region for H. pylori infection. Douraghi et al and Dabiri et al, have studied these genes in Tehran, Iran (13, 15). However, no evaluation has been done in West of Iran. According to our results, the prevalence of this bacterium was 87% and 82% by RUT and

| Gene | Gastric Ulcer n=18 | Duodenal Ulcer n=33 | Gastric Cancer n=3 | Gastritis n=120 | Duodenitis n=6 |
|------|--------------------|---------------------|------------------|----------------|---------------|
| dupA | 7 (38.88%)         | 13 (39.39%)        | 0 (0.00%)        | 37 (30.83%)    | 2 (33.33%)    |
| oipA | 14 (77.77%)        | 27 (81.81%)        | 1 (33.33%)       | 88 (73.33%)    | 4 (66.66%)    |
PCR, respectively which is similar to previous reports from Iran (2, 15). Lu et al. demonstrated that the existence of the jhp0917 and jhp0918 genes, which located in the plasticity region, forms one gene (dupA) (11). The correlation of the dupA with clinical outcome is still controversial. Some researchers have shown that the gene is associated with an increased risk of duodenal ulcer and protection against gastric atrophy, intestinal metaplasia and gastric carcinoma in Japan and Korea (3, 11). Likewise, the gene was shown to be protective against gastric carcinoma in Colombian patients (11). Quiroz et al. from Brazil and Imagawa et al. from Japan suggest that there is no association between dupA with duodenal diseases, but strains containing dupA without the stop codon polymorphisms were associated with lower risk for development of gastric carcinoma (20, 21). However, some groups such as Gomes et al. in Brazil and Nguyen et al. in Japan did not find any significant association between dupA gene and duodenal ulcer disease (14, 19). The prevalence of dupA (both jhp0917 and jhp918) varies from 6% to 92% according to different studies around the world (3). Our results, similar to Lu et al. from Colombia and Zheng et al. from China showed that both jhp0917 and jhp0918 genes were present in 33.33% of isolates (11, 22). However, in our study, 6% of H. pylori strains did not contain jhp0918 gene. This finding is similar to those of Archachi et al. that showed 11% of cases were negative for jhp0918. It is likely that dupA gene without jhp0918 is not functional (12). When we came to analyze association of dupA status with clinical outcomes, our results were in accordance with Queiroza et al. and Imagawa et al. (20, 21). They showed there was no association between dupA gene and duodenal ulcer disease but there was a statistical significant association between the lack of this gene in strains and development of gastric cancer (20, 21). The presence of the dupA gene prevents the development of gastric cancer. The OipA is a member of the large outer membrane protein family whose functional status is regulated by slipped-strand mispairing based on the number of CT dinucleotide repeats in the 5’ region of the gene (a switch status of “on” indicates the gene is functional, and a switch status of “off” indicates it is non-functional) (15, 23).

Using primers for detection of oipA gene, we figured out 71.54% of isolated strains contain this gene which is in accordance with our previous study that showed the oipA prevalence varies from 33% to 71% in Iranian population based on different ethnic background (13). In contrast with Yamaoka et al. and Kudo et al. identified the oipA gene from 45.9% and 30% of studied H. pylori isolates respectively (8, 24). In majority of studies, the oipA gene was present in most strains. In contrast, there were many oipA-negative cases in the current study. We used the same PCR primers as used in previous studies, which worked well both in Asian and Western strains. Therefore, there should be two possibilities: one is the nucleotide sequences of PCR primer regions are considerably different in Iranian strains from other countries and another possibility is that there are oipA-negative strains in Iran. More studies are needed for approving which possibilities will be applied to Iranian strains. Shao et al. declared there is no correlation between oipA gene and gastric diseases (25), while similar to our previous result; we interestingly found this gene to be significantly more common in non-ulcer dyspepsia patients rather than peptic ulcer dyspepsia cases (7, 15). Previously we have reported that the presence of the oipA is equal with low risk for GC development, while in the current study we did not find the same correlation (15). Overall, the presence of the oipA gene and clinical outcomes are still unclear. In previous studies, the oipA gene was present in most strains and the oipA status was evaluated by functional status (i.e. ‘on’ or ‘off’ status). As the numbers of patients in the current study were relatively small, further studies with larger numbers are necessary to clarify the
roles of oipA in clinical outcomes. As a result of our findings, there was a statistically significant relationship between the lack of oipA gene and the presence of dupA in isolated strains. This is compatible with those of Matteo et al., which suggested that these genes are present with each other only in one tenth of strains (5).

In conclusion, according to the results there was a reverse correlation between the dupA gene presence and gastric cancer as well as dupA and oipA gene. While the oipA gene is only statistically associated with gastritis, which is not consider as a severe dupA gene, an important marker for more severe gastrointestinal disease prediction. However, this fact does not apply for oipA gene among patients in the west of Iran. Finally, further and extended molecular epidemiology researches in other parts of Iran are recommended.

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