The COX-2 -765 G>C Polymorphism is Associated with Increased Risk of Gastric Carcinogenesis in the Chinese Hui Ethnic Population

Wen-Ting He¹,²&, Tao Liu¹,²&, Xiao-Fan Tang², Yu-Min Li¹,²*

Abstract

Background: The Chinese Hui ethnic group has diverse origins, including Arab, Persian, Central Asian, and Mongol. The standardized mortality rate of gastric cancer in the Hui population is higher than the overall Chinese population. In this study, we investigated whether COX-2-765G>C polymorphism, an extensively studied polymorphism, contributes to gastric cancer and its precursor lesions (GPL) in the Chinese Hui ethnic group.

Materials and Methods: COX-2-765G>C polymorphism was determined by pyrosequencing in 100 gastric cancer cases, 102 gastric cancer and its precursor lesions cases and 105 controls. Data were statistically analyzed using Chi-square tests and logistic regression models. Results: Among the Chinese Hui ethnic group COX-2 -765 C allele carriers were at increased risk for gastric cancer (OR=1.977, 95% CI=1.104-3.541). We also found an interaction between COX-2 -765 C carriers and Helicobacter pylori infection and eating pickled vegetables.

Conclusions: Our findings suggest a multi-step process of gene-environment interaction contributes to gastric carcinogenesis.

Keywords: Cyclooxygenase-2 - gastric cancer - gastric precursors lesions - polymorphisms - Helicobacter pylori

Introduction

Gastric cancer is a major health problem, being the most common malignancy in the world with an estimated one million new cases every year (Hartgrink et al., 2009). The high morbidity areas are found in Asia, especially China. It is reported that the standardized mortality rate of gastric cancer in Hui population is higher than the average of China (The Data-Center of China Public Health Science). In China, Hui minority ethnic populations are descendant of Mongols and Muslims immigrants. Through interracial breeding between the Han, the Mongols, and the Uygur, they developed the Hui nationality. There are many concentrated Hui communities in Gansu province where there are high incidence areas of gastric cancer. Our previous study suggests COX-2 plays an important role in carcinogenesis and its polymorphisms, including a new single nucleotide polymorphism (SNP) are associated with susceptibility to gastric cancer in the Han population in Gansu Province (Li et al., 2006; Li et al., 2010; Zhu et al., 2010). To the best of our knowledge, there are no other reports on the SNPs of COX-2 and its association with increased gastric cancer risk in the Chinese Hui population. In this study, we investigated whether the COX-2-765G>C polymorphism contributes to gastric cancer in the Chinese Hui ethnic population.

Materials and Methods

Study population

Subjects investigated were Muslim inhabitants, who lived in Linxia Hui Autonomous Prefecture for more than 20 years with three generations of non-ethnic marriage. The case control study was undertaken between October 2010 to November 2012, and consisted of 100 gastric cancer patients, 102 precancerous lesion patients and 105 control subjects. Participants were recruited from 2A grade hospitals in Gansu Province. The diagnosis of gastric cancer and precancerous lesion were on the basis of clinical, endoscopical and histopathological examinations. The 105 control subjects were confirmed to be free of the disease by a health examination, involving endoscopy or upper gastrointestinal investigation. Subjects were informed of the detailed study protocol and signed consent forms, and the study was approved by local ethics committees.

A questionnaire collected information on (a) demographic factors, such as age, sex, ethnic, native place; (b) medical history of digestive disease and family history of gastric cancer. Subject with at least one first-degree relative (a parent or sibling) or two second-degree relatives (grandparents, aunts, or uncles) with gastric cancer (GC) were considered to have a positive family
Each subject donated 3 mL peripheral vein blood in EDTA-K2 anticoagulant tube for DNA extraction and 2 mL serum for 
*H. pylori* infection test, and all specimens were kept frozen at -80°C.

Sample DNA extraction

Blood samples were collected with a standard venupuncture technique using EDTA containing tubes. Genomic DNA was extracted using EZ Spin Column Genetic DNA Isolation Kit (BBI, Canada) following the manufacturer’s instructions. The integrity and purity were determined by using agarose gel electrophoresis and a spectrophotometer respectively. The final concentration of each DNA sample was adjusted to approximately 20 ng/mL and stored at -80°C until use.

Detection of *H. pylori* infection

Presence and type of *H. pylori* infection were tested using a *H. pylori* antibody Immunoblotting Kit (Blot Biotech, Shenzhen, China) following the manufacturer’s instructions. Type I *H. pylori* infection was defined when either CagA or VacA was positive, or both were positive. TypeII *H. pylori* infection was defined if ureases (UreA/ UreB) were positive. Patients were defined as *H. pylori* negative if CagA, VacA and ureases were negative.

Genotyping of COX-2-765G>C polymorphism

COX-2-765G>C polymorphism was determined by pyrosequencing technology. PCR primers and sequencing primer were designed by Takara BioTechnology (Dalian) Corporation Limited. The sequences of PCR primers were as follows: forward primer was TTATTTGTGCAACCGTGAA, and reverse primer was biotinylated-CCTTCACCCCCTCCTTGTTT. The sequencing primer was GGAGAATTCTACCTTCC. All primers were validated by basic local alignment search tool (BLAST) homology searches (http://www.ncbi.nlm.nih.gov).

Quality control

Twenty percent of samples from patients and controls were regenotyped by other laboratory personnel, and results showed 100% similarity in both of the conditions. No discrepancy was found after sequencing randomly selecting 10% of the samples.

Statistical analysis

The Hardy-Weinberg equilibrium equation was used to determine whether the proportion of each genotype obtained was in agreement with expected values as calculated from allele frequencies. Student and Chi-square test analyses were used to compare categorical variables and genotype frequencies between GC, GPL and controls, using a 5% level of significance. Odds ratios (ORs) and 95% confidence intervals (CIs) calculated bivariate conditional logistic regression analysis was performed to analyze the association between the genotypes of COX-2 and the risk factors of GC. Multivariate logistic regression was used to analyze all risk factors with GC and GPL.

Allele frequency distribution was stratified by age, sex, GC family history, eating pickles history and *H. pylori* infection, and interactions were considered in the model. All data analysis was performed using the computer software SPSS 13.0 (SPSS Inc., Chicago, IL, USA).

### Results

**Demographic and clinical characteristics**

The frequency distribution of sex, age, *H. pylori* infection, family history and eating pickle vegetables in subjects with gastric cancer, GPL and controls is presented in Table 1. Rates of *H. pylori* infection and eating pickled vegetables were significantly higher in gastric cancer and GPL participants compared to controls whereas no significant differences were seen between gastric cancer and GPL. The rates of gastric cancer family history was significantly higher in gastric cancer and GPL participants compared to controls. The was nonsignificant differences in age and sex between gastric cancer and GPL participants compared to controls.

**Genotype frequencies of COX-2-765G>C polymorphism**

The distribution of COX-2-765G>C polymorphism was consistent with Hardy-Weinberg’s equilibrium in healthy controls. However, the COX-2-765 CC genotype significantly increased the risk for gastric cancer (OR=2.400) compared to the GG genotype (*p*=0.029) (Table 2).

**Stratification analysis of COX-2-765G>C polymorphism**

The risk of GPL or gastric cancer related to COX-2-765G>C genotypes were further examined with stratification by *H. pylori* infection, family history and eating pickled vegetables (Table 3). The intake of pickled vegetables was the most important factor. The presence of the -765C allele in subjects with eating pickled vegetables conferred a 3-fold risk of gastric cancer compared to GG genotypes. However, individuals carried C allele appeared to have no association between

### Table 1. Demographic Characteristics and Risk Factors in Subjects with Gastric Cancer or GPL, and Control Subjects

| Variable                  | Control (n=105) | GPL (n=102) | Gastric cancer (n=100) | p-Valuea |
|---------------------------|-----------------|-------------|------------------------|----------|
| Age                       | 58.3±11.4p      | 58.1±11.3   | 58.5±11.2              | 0.922    |
| <60 [n (%)]               | 45(42.9)        | 44(43.1)    | 42(42.0)               |          |
| ≥60 [n (%)]               | 60(57.1)        | 56(56.9)    | 58(58.0)               |          |
| Sex                       |                 |             |                        | 0.953    |
| Female                    | 34(32.4)        | 33(32.4)    | 32(32.0)               |          |
| Male                      | 71(67.6)        | 69(67.6)    | 68(68.0)               |          |
| *H. pylori* infection [n (%)] |             |             |                        | 0.039    |
| Yes                       | 52(49.5)        | 65(63.7)    | 67(67.0)               |          |
| No                        | 53(50.5)        | 37(36.3)    | 33(33.0)               |          |
| Family history [n (%)]    |                 |             |                        | 0.028    |
| Yes                       | 12(11.4)        | 15(14.7)    | 23(23.0)               |          |
| No                        | 93(88.6)        | 87(85.3)    | 77(77.0)               |          |
| Eating pickle vegetables [n (%)] |         |             |                        | 0.023    |
| Yes                       | 23(21.9)        | 37(36.3)    | 42(42.0)               |          |
| No                        | 82(78.1)        | 65(63.7)    | 58(58.0)               |          |

*a*: *p*-Values from Student’s t-test and chi-squared test. b: Mean ±SD.c: At least one first-degree relative (a parent or sibling) or two second-degree relatives (grandparents, aunts, or uncles) with gastric cancer. d: Continuous history of 10 years or more, no less than 3 months per year
In this study, we found H. pylori infection increased the risk of gastric diseases, but there was no difference between gastric cancer and GPL groups. This finding suggests that H. pylori infection didn’t aggravate inflammation reactions, and was only an early event during development of gastric cancer. Some studies investigating the effect of H. pylori eradication have shown contradictory results for reversibility of precursor lesions and reduction of gastric cancer rate (Kuipers and Sipponen., 2006). Therefore, H. pylori eradication was a good prophylactic method but clinical way.

Gene polymorphisms vary substantially between ethnic groups. As a results it is important to identify the susceptible genes in different ethnicity. COX-2 is a rate-limiting enzyme that catalyzes the formation of prostaglandins (PG) from arachidonic acid (AA). COX-2 -765 G>C is one of the most extensively studied polymorphisms. It has been reported that the -765 CC genotype does not exist in Han population (Liu et al., 2006; Tan et al., 2007). However, we found the frequency of genotype was about 5% -765 G>C increased the risk of gastric cancer in the Han population. Pereira et al. found similar results amongst Portuguese populations (Pereira et al., 2006). However, Sitarz et al. findings suggest the polymorphism plays a protective role in the development of gastric cancer (Sitarz et al., 2008). Interestingly, they founded there was no correlation between the presence of the C allele and a difference in COX-2 expression. In addition, this polymorphism showed no associations with gastric cancer and precancerous lesions risk in Chinese Han people. [9] Therefore, it might indicate that the -765 G>C polymorphism plays a role in carcinogenic processes in specific populations.

The present study has some limitations. The sample size was relatively small, although it was sufficient to detect moderate associations. In addition, the risk of GC related to the COX-2 SNP might be influenced by use of non-steroidal anti-inflammatory drugs. Those factors might interact with COX-2 genotype or act as potential confounder in the analysis. Unfortunately, information on this factor in the present study was unavailable. It would be important in the future to investigate the interaction between the genotype and the expression in vitro.

In summary, this study provides evidence that the COX-2-765 G>C polymorphism increased the genetic susceptibility of gastric cancer in Hui population. We also found an interaction among H. pylori infection, eating pickle vegetables and the COX-2 -765 C carriers.
Acknowledgements

This work was supported by National Natural Science Foundation of China (No. 31300429 and No. 31270532) and the Fundamental Research Funds for the Central Universities (No. Izujbky-2013-137).

References

Hartgrink HH, Jansen EPM, van Grieken NCT, et al (2009). Gastric cancer. Lancet, 374, 477-90.

Kuipers EJ, Sipponen P (2006). Helicobacter pylori eradication for the prevention of gastric cancer. Helicobacter, 11, 52-7.

Li YM, He WT, Liu T, et al (2010). A New Cyclo-Oxygenase-2 Gene Variant in the Han Chinese Population is Associated with an Increased Risk of Gastric Carcinoma. Mol Diagn Ther, 14, 351-5.

Li YM, Praseedom RK, Butler A, et al (2006). COX-2 inhibitor and gastric cancer. In: Maynard JH, ed. COX-2 inhibitor research, pp1-83. Nova Science Publishers, New York.

Liu F, Pan KF, Zhang XM, et al (2006). Genetic variants in cyclooxygenase-2: expression and risk of gastric cancer and its precursors in a Chinese Population. Gastroenterol, 130, 1975-84.

Pereira C, Sousa H, Ferreira P, et al (2006). -765G > C COX-2 polymorphism may be a susceptibility marker for gastric adenocarcinoma in patients with atrophy or intestinal metaplasia. World J Gastroenterol, 12, 5473-8.

Ren JS, Kamangar F, Forman D, et al (2012). Pickled food and risk of gastric cancer—a systematic review and meta-analysis of English and Chinese literature. Cancer Epidemiol Biomarkers Prev, 6, 905-15.

Sitarz R, Leguit RJ, de-Leng WW, et al (2008). The COX-2 promoter polymorphism -765 G>C is associated with early-onset, conventional and stump gastric cancers. Mod Pathol, 21, 685-90.

Tan W, Wu JX, Zhang XM, et al (2007). Associations of functional polymorphisms in cyclooxygenase-2 and platelet 12-lipoxygenase with risk of occurrence and advanced disease status of colorectal cancer. Carcinogenesis, 28, 1197-201.

The Data-Center of China Public Health Science. The gastric cancer adjust mortality, cumulative mortality and sexual ratio of Chinese part minority. Available from URL: http://www.phsciencedata.cn

Uemura N, Okamoto S, Yamamoto S, et al (2001). Helicobacter pylori infection and the development of gastric cancer. New Engl J Med, 345, 784-9.

Yaegashi Y1, Onoda T, Morioka S, et al (2014). Joint effects of smoking and alcohol drinking on esophageal cancer mortality in Japanese men: findings from the Japan collaborative cohort study. Asian Pac J Cancer Prev, 15, 1023-9.

Zhu KX, Li YM, Li X, et al (2010). Study on the association of COX-2 genetic polymorphisms with risk of gastric cancer in high incidence Hexi area of Gansu province in China. Mol Biol Rep, 38, 649-55.