

# Comparative Study on $^{13}\text{C}$ Breath Test by Gas Isotope Ratio Mass Spectrometer and Infrared Spectrometer

Xingqi Gao, Xingdang Liu, Xueping Zhang

(Department of Nuclear Medicine, Huashan Hospital, Fudan University, 200040)

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## Abstract

To detect the sample content respectively via gas isotope ratio mass spectrometer and infrared spectrometer, analyze and compare two methods in their correlation and respective advantages. And it finds that the two methods are in good agreement with high sensitivity and reproducibility.

## Key words

$^{13}\text{C}$ - urea breath test; isotope ratio mass spectrometer; infrared spectrometer

Helicobacter pylori (HP) is considered to be one of the important causes for gastritis, peptic ulcer, gastric cancer, liver disease and other digestive diseases<sup>[1]</sup>, and related to many gastrointestinal disorders, is also one of main risk factors leading to gastric dysplasia and cancer<sup>[2]</sup>. Since Hp was found, numerous research by clinicians and researchers have made its pathogenic mechanism clear basically, but also provided a theoretical basis for the treatment of gastritis, peptic ulcer, gastric cancer and other diseases. Therefore, screening and treatment for early H. pylori infection are prerequisite and effective measures for the prevention of gastric cancer<sup>[3]</sup>.

## 1. Materials and Methods

### 1.1 Subjects

33 samples of outpatients and inpatients are included totally. Their age are (25-70) years, with mean age ( $44.7 \pm 11.6$ ) years.

### 1.2 Detection reagents

The detection reagents are supplied from Proto Co., USA and Beijing Richen-Force Science & Technology Co. Ltd.

### 1.3 Instruments

The detection instruments include isotope ratio mass spectrometer PROTO2005 manufactured by Proto Co., USA and HG-IRIS infrared spectrometer provided by Beijing Richen-Force Science & Technology Co. Ltd.

### 1.4 Methods

The same sample of 33 cases is detected on content by isotope ratio mass spectrometer and infrared spectrometer according to reagent instructions. Regarding to the outpatients of our hospital, the same sample is analyzed respectively by gas isotope ratio mass spectrometer and infrared spectrometer. Steps: ① subjects preparation: At first the unified requirement for subjects shall be met before taking breath test, such as overnight fasting, keeping rest. ② the blank

sample collection. ③  $^{13}\text{C}$  marker intake. ④ gas sample collection of test points. ⑤ sample test: gas isotope ratio mass spectrometer and infrared Spectrometer. ⑥ calculation and analysis of the results.

### 1.5 Statistical Analysis

The data are analyzed statistically by SPSS10.0 software, with the value expressed as  $\bar{x} \pm s$ .

## 2. Results

2.1 The test results by isotope ratio mass spectrometer and an infrared spectrometer are listed in Table 1.

Table 1 The test results by two methods

Patient sample of 33 cases	DOB value	Positive results	Negative results
Isotope ratio mass spectrometer	$20.96 \pm 25.39$	16	17
Infrared spectrometer	$19.74 \pm 24.50$	15	18

The results tested by two methods of isotope ratio mass spectrometer and infrared spectrometer show that: Pearson method of chi-square test  $\chi^2 = 0.61$ ,  $P < 0.805$ , the comparison difference between two methods is not statistically significant.

2.2 Referred to the normal range of two methods, the result greater than the upper limit of normal is positive, and vice versa for negative. The comparisons on positive and negative coincidence rate tested by two methods are listed in Table 2.

Table 2 Comparisons on two detection method

Comparison on ratio mass spectrometer and infrared spectrometer	coincidence rate of positive results	coincidence rate of negative results	total coincidence rate
	87.5(14\16)	94.1(16\17)	90.9(30\33)

## 3. Discussion

This study proved  $^{13}\text{C}$ - urea breath test on subjects is a non-invasive, simple, quick, repeatable detection method. Because the HP in the stomach is distributed as "focal", false positive results will be got if the biopsy method is used. But oral  $^{13}\text{C}$ - urea can distribute evenly in stomach, the infection site can be detected sensitively as long as there is HP stomach infection. After taking 75 mg  $^{13}\text{C}$ - urea orally for 30 minutes, the subjects can be tested with reliable results just taking a breath. If only for detection of H. pylori, this method can avoid the inconvenience of acquiring gastric mucosa for diagnosis by gastro scope, and therefore be also recognized internationally as the gold standard for Hp diagnosis.

$^{13}\text{C}$ -urea breath test via gas isotope ratio mass spectrometer is a method to detect the amount of  $\text{CO}_2$  in the breath for determination of Hp level in human body with  $^{13}\text{C}$ -labeled urea as tracers based on the decomposition characteristics of Hp endogenous urease on urea. Because urease

exists in HP bacteria, it will decompose the  $^{13}\text{C}$ -urea swallowed into  $^{13}\text{CO}_2$  in the stomach, which will be absorbed through the gastrointestinal tract to reach the pulmonary blood circulation and then exhaled with breath. As long as we collect the exhaled gas, and test the content of  $^{13}\text{C}$ -labeled  $\text{CO}_2$ , it can be determined accurately with HP infection or not<sup>[6]</sup>. For people without HP infection,  $^{13}\text{C}$ - urea will not be decomposed in the stomach, and just discharged through the urinary system, without any detection in breath. But the exhaled gases from patients with HP infection will be detected with  $^{13}\text{CO}_2$ .

Infrared spectrometer is composed of  $^{12}\text{CO}_2$  and  $^{13}\text{CO}_2$  detectors with high selectivity. And the detection is based on the specific absorption of  $\text{CO}_2$  on the infrared spectrum under the wavelength between 2-8 $\mu\text{m}$ . By using special optical designs and mathematical methods, infrared spectrometer reduces the mutual interference between  $^{13}\text{CO}_2$  and  $^{12}\text{CO}_2$ , and improves the measurement precision while ensuring the accuracy of the system. Moreover, in order to further ensure the accuracy of the system, heat insulation measures are used during study.

The two methods of gas isotope ratio mass spectrometer and infrared spectrometer have good consistency, as well as with high sensitivity and repeatability, which are beneficial to large quantities of clinical detection requirements and worthwhile for further research and extension.

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