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The Oral Transmission of *Helicobacter pylori* Infection

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INTRODUCTION

A Gram Negative spiral bacterium, now called *Helicobacter pylori* (*H. pylori*), is frequently found in patients with gastritis, gastroduodenal ulcer, and gastric cancer. It was suspected that this organism might play a role in the pathogenesis of these diseases. Although a variety of studies have been conducted on *H. pylori* since its discovery in 1983 [1], there still were many areas of uncertainty. This is because *H. pylori* is found only in the human gastric mucosa, and thus it was difficult to carry the experiments to study its pathogenicity.

We believed studying animals susceptible to colonization with *H. pylori* would greatly facilitate the studies aimed at clarifying its pathogenicity. Such a test model is advantageous in that the animals are easy to handle, widely available, and inexpensive, thus permitting a wide variety of experiments to be carried out. As a result, we achieved continuous colonization with *H. pylori* in the gastric mucosa of nude mice and euthymic mice in 1990 [2], using freshly isolated strains of *H. pylori* obtained from patients with gastritis, gastric ulcer, and duodenal ulcer. Moreover, we developed the *H. pylori* infected rodent model using a Mongolian gerbil which was observed severer inflammation and the ulceration in 1996 [3]. In addition, the gastric mucosa would not be colonized unless freshly isolated strains of *H. pylori* was used, by the established strains.

To establish the *H. pylori* infected mouse model, the challenged *H. pylori* inocula such as two-milliliter aliquots of the culture fluid of *H. pylori* with a concentration of 10^8 organisms/ml (adjusted as the report) were prepared on a one-time basis.

This *H. pylori* infected model to which extraordinary high concentrated inocula is administered is one of the *H. pylori* infected case by the oral transmission of *H. pylori* which is unrealistic large amount of *H. pylori*. Then, what is the source of natural *H. pylori* transmission in case of oral transmission? One example is *H. pylori* infected human. However, this source is not highly concentrated *H. pylori*. Therefore, it is speculated that the intimate interaction is required for *H. pylori* transmission.

There have been several reports about the mode of transmission of *H. pylori*. It is suggested that the representative route of *H. pylori* transmission is presumably close personal contact, as mentioned above, special among the familial members. Instead of demonstrating the *H. pylori* transmission among the humans, we demonstrated the *H. pylori* transmission from challenged to non-challenged mice in a single cage using the mouse model we developed previously [2].

The results [4] are following:

Six mice were challenged with *H. pylori* inocula; one group consisted of one challenged mouse 1 week after inoculation raised with four non-challenged mice in a single cage. For the single cage, a polycarbonate cage or a mesh floor cage was used. The three groups were kept in a polycarbonate cage and the other three groups kept in a mesh floor cage to avoid *H .pylori* transmission through stool. During 3 weeks after co-raising of *H. pylori* challenged and non-challenged mice, *H. pylori* was detected in the stomachs in 3 of 12 non-challenged mice in the polycarbonate cage and in 2 of 12 non-challenged mice in the cage with a steel mesh floor. *H. pylori* was detected from saliva or stool in two non-challenged, infected mice in the polycarbonate. Moreover, RAPD fingerprinting of the total five strains isolated from five non-challenged infected mice both cages showed the same pattern and concordance with that of the challenged strain and the strains isolated from challenged mice. After coraising for 1 or 2 weeks, *H. pylori* was detected in the stomach in only 1 of 48 non-challenged mice in both cages.

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Moreover, food and drinking water is thought to be the source of *H. pylori* infection through the oral route, such as the *H. pylori* infected person. Waterborne *H. pylori* transmission was previously reported [5].

To clarify the route of *H. pylori* transmission in Japan, the serological prevalence of *H. pylori* infection were measured by ELISA, its background in the families examined, and histories were obtained from 41 enrolled families [6].

The results [6] are following:

The Hp (*H. pylori*) status of their 82 parents (41 fathers and 41 mothers) was positive in 57 (32 males and 25 females) and negative in 25 (9 males and 16 females). The Hp status of the parents had the same trend according to the age. The relationship between several factors and Hp infection of children (17 positive and 63 negative) was evaluated as shown in **Table 1**.

Table 1: Relationship of several factors and Hp prevalence in children.

	Hp+	Hp-	P*
Age (yr)			
1-10	1	26	
11-20	7	24	
>20	9	13	0.0016
Sex			
F	14	34	
M	3	29	0.0498
Well water			
+	14	13	
-	3	50	<0.0001
Municipal water			
+	11	58	
-	6	5	0.0095
Father Hp			
+	16	47	
-	1	16	0.1026
Mother Hp			
+	13	38	
-	4	25	0.2662
Alcohol			
+	3	5	
-	14	58	0.3568
Tobacco			
+	3	5	
-	14	58	0.3568
Antibiotics			
+	5	18	
-	12	45	1
NSAID			
+	7	26	
-	10	37	1
Total	17	63	

**Wilcoxon test was used for age and Fisher's exact was used for other factors.*

The factors were age (1-10, 11-20, 21-38 years old), sex, water supply (well water and municipal water), Hp status of father and mother, cigarette, alcohol, antibiotics use, and NSAIDs use. The Wilcoxon test was used for age and Fisher's exact test for the other factors. Age, sex, and history of drinking well water are substantially associated with Hp infection. The history of municipal water drinking is significantly negatively associated with Hp infection. Therefore, logistic regression was used to evaluate the relationship between age, sex, or history of drinking well water and Hp infection of children. Then, the history of drinking well water is substantially associated with Hp infection after adjustment for age and sex (odds for 1 year: 1.19 and 95% CI: 1.08-1.32) and, age and sex is not significantly associated with Hp infection. Next, we evaluated the duration of drinking well water and found a strong significant association with Hp prevalence in 80 children as shown in **Table 2**.

Table 2: Relationship between duration of drinking well water and Hp prevalence in children*

Well history (yr)	Hp+	Hp-	Total
0	3	50	53
0-5	3	8	11
5-10	0	2	2
10-15	4	1	5
15-20	3	2	5
>20	4	0	4
Total	17	63	80

**P<0.0001; Wilcoxon test was used.*

Upper gastrointestinal endoscopies were performed on selected family members with symptoms, and *H. pylori* strains from these families were isolated and RAPD performed to explore the route of *H. pylori* infection. *H. pylori* prevalence in the 41 families increased with age, and there is strong relationship between *H. pylori* serological prevalence and a history of drinking of well water. Among the people who have a history of drinking well water, *H. pylori* prevalence in those at least 10 years old was 85.3%, which is significantly higher than that in those less than 10 years old (25%) and no history of drinking well water (6.3%). There were 5 families with *H. pylori* serologically positive members who have drunk well water. RAPD fingerprinting of isolated *H. pylori* strains from these family members also suggested that the origin of *H. pylori* infection was well water [6].

In spite of Japan being a developed country, the reported prevalence of *H. pylori* infection is higher than that of other developed countries. This indicates that many houses have private wells and had drunk well water rather than the municipal water with good sanitation 35 years ago in Japan. Municipal water with good sanitation was available to 69.4% of Japan at that time. The availability of municipal water was increased about 5% every 5 years and reached 94.7% in 1990 and increasing in subsequent years. It is speculated that most *H. pylori* transmission in Japan depends on waterborne transmission and the occurrence of its transmission is strongly associated with the duration of the history of drinking well water.

CONCLUSION

Our data suggested that the contagion of *H. pylori* mainly occurred via the drinking well water in Japan. The prevalence of *H. pylori* infection is decreasing with lower age in the world including Japan. It is easy to imagine that this finding is linked with that drinking well water is being avoided and the sanitary environment is being improved in the home. As a result, the sanitary environment and *H. pylori* eradication induce the *H. pylori* prevalence to have been steadily declining more and more in the world. However, the other several contagion routes are also thought excluding the water transmission. Then, to precisely understand the route of the contagion of *H. pylori*, the more other factors excluding the water transmission from well, which are not listed in Table 1, must be evaluated. Moreover, to evaluate the contagion of *H. pylori* via well water, further studies are required to isolate *H. pylori* from the well water and determine whether the isolated strain from well water is identical to the strain isolated from the person who drank that water. We still have not succeeded it, yet.

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