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Natural Mannose-Binding Lectin (MBL) Down-regulates Phagocytosis of *Helicobacter pylori*

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A b s t r a c t

Considering the role of lectin-carbohydrate interactions between *Helicobacter pylori* bacteria and the host cells we addressed the question on how mannose binding lectin – MBL, present in human plasma, may influence the phagocytosis of *H. pylori* by peripheral blood granulocytes. For phagocytosis assay the granulocytes separated from peripheral blood of healthy *H. pylori*-seronegative donors were used. Phagocytosis was estimated by fluorescence assay using FITC-labelled *H. pylori* cells. The MBL level in the serum samples as well as MBL-binding to *H. pylori* bacteria were estimated by ELISA. In this study all *H. pylori* isolates bound recombinant mannose binding lectin-MBL as shown by ELISA. The ingestion of *H. pylori* bacteria in the medium with human serum depleted in natural MBL (nMBL) was more intensive than in the medium with complete serum containing nMBL. Moreover, the ingestion of *H. pylori* bacteria in the medium with complete serum was increased by an addition of anti-rMBL IgG. The results indicate that interaction of bacterial and host lectins may regulate the phagocytosis of *H. pylori* bacteria and in this way influence an outcome of the infection caused by these microbes.

K e y w o r d s: *Helicobacter pylori*, mannose binding lectin (MBL), phagocytosis

Introduction

Helicobacter pylori related gastroduodenal infections are associated with strong infiltration of the gastric mucosa by neutrophils, macrophages, lymphocytes and plasma cells (Rudnicka and Andersen, 1999). Despite mobilization of phagocytes to inflammatory foci, the bacteria are not eliminated. It has been suggested that they may evade destruction by phagocytes due to a temporary persistence in the cytosol of epithelial cells (Petersen and Krogfeld, 2003). Many *H. pylori* strains express adhesin proteins that bind to specific host cell macromolecule receptors. The best defined *H. pylori* adhesin-receptor interaction, described by Ilver *et al*. (1998), is that between the Lewis b (Le b) blood group antigen binding adhesin, BabA, a member of a family of *H. pylori* outer membrane proteins.

Mahdavi *et al*. (2002), identified sialyl-dimeric Lewis X glycosphingolipid as a receptor for *H. pylori*. The corresponding sialic-acid-binding adhesin (SabA) was isolated and the *sabA* gene was identified (Mahdavi *et al*., 2002). It has also been established that *H. pylori* strains express heparan sulphate binding proteins (Hirmo *et al*., 1995).

Two molecular mechanisms of microbial recognition by phagocytes are distinguished: direct – opsonin independent, and indirect – opsonin dependent (Ofek *et al*., 1995) In our previous study we found that antibodies specific to various *H. pylori* antigens may have opposite effects on the course of phagocytosis of these bacteria. We showed that opsonization of *H. pylori* with anti-Lewis X monoclonal antibody (IgM)

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made Lewis X-positive but not Lewis X-negative *H. pylori* bacteria more susceptible to phagocytosis (Chmiela *et al*., 1997, 1998, Rudnicka *et al*., 2001). However, sera from dyspeptic patients with IgG against *H. pylori* surface antigens reduced the susceptibility of these bacteria to phagocytosis (Rudnicka *et al*., 1998). The importance of opsonic activity of the complement in the ingestion of *H. pylori* bacteria by neutrophils was also shown (Mc Kinlay *et al*., 1993). On the other hand, Rautelin *et al*. (1994), showed that about one third of *H. pylori* strains isolated from human gastric biopsy specimens, induced strong chemiluminescence in neutrophils, even without serum opsonins.

Lectinophagocytosis is a known example of opsonin independent phagocytosis. It includes the reaction between surface lectins and carbohydrates on microbial or phagocytic cells (Ofek *et al*., 1995). Previously we showed that interaction between bacterial surface structures such as sialic acid specific haemagglutinins, heparin binding proteins and corresponding phagocyte receptors was necessary for the ingestion of *H. pylori* (Chmiela *et al*., 1998). On the other hand, our results suggested that *H. pylori* can use widely distributed host compounds: sialic acid or heparin/heparan sulfate glycosaminoglycans, hyaluronic acid or vitronectin (in the presence of complement) to avoid phagocytosis (Chmiela *et al*., 1998).

Mannose binding lectin – MBL, a C-type lectin, interacts with various microbial carbohydrates (mannose, N-acetyloglucosamine, fucose and N-acetylomannosamine) (Sastry and Ezekowitz, 1993; Turner, 1996). The bacterial capsule and especially LPS could be a major determinant for MBL binding (Devyatyarnova-Johanson *et al*., 2000). MBL activates complement on lectin pathway, independent of C1q and antibodies, in the presence of MBL-associated serine proteases (MASP1 and MASP2, homologues of C1q and C1s) (Gal and Ambrus, 2001; Kase *et al*., 1999; Matsushita and Fujita, 1992). Garred *et al*. (2003), proposed a dual role of MBL dependent on the lectin's concentration. Low concentrations have been associated with recurrent or severe infections in children and adults caused by extracellular pathogens and also with autoimmune diseases. High concentrations may enhance targeting of intracellular organisms to host phagocytes. MBL also modulates disease severity, at least in part through a complex, dose dependent influence of cytokine production (Matsushita and Fujita, 1992).

In this study we addressed the question on how MBL may influence the phagocytosis of *H. pylori* by human granulocytes. In order to answer this question we estimated: 1) interaction of MBL with *H. pylori* clinical isolates and reference strains, 2) MBL concentration in the sera from *H. pylori* infected and uninfected children/adolescents and adults, 3) the intensity of *H. pylori* ingestion by human granulocytes in the presence or absence of natural (nMBL) and recombinant (rMBL) mannose binding lectin as well as anti-rMBL IgG antibodies.

Experimental

Material and Methods

Serum samples. A total of 224 sera were examined for MBL concentration. Sera from *H. pylori* positive (69) and negative (49) children/adolescents (average age 13 years) diagnosed for *H. pylori* infection in Mother Health Center Institute in Łódź, Poland, were used for the study. The serum samples from *H. pylori* positive (66) or negative (40) adult dyspeptic patients (average age 53 years) were obtained from K. Jonscher Hospital in Łódź, Poland. *H. pylori* status was determined by endoscopy, rapid urease test and histology. Moreover, in all subjects the titers of anti-*H. pylori* IgG and IgA antibodies were estimated by immunoenzymatic test – ELISA with glycine acid extract of the reference *H. pylori* strain, as previously described (Rechciński *et al*., 1997). The study was approved by the local Ethical Committee. All patients signed informed consent.

ELISA for serum MBL concentration. The microtitre plates (Nunc Immunoplate Maxisorp, Nunc, Kastrup, Denmark) were coated with *S. cerevisiae* mannan (Sigma, St. Louis, Michigan, USA) at a concentration of 250 µg/ml in carbonate buffer pH 9.6 (Aittoniemi *et al*., 1996). The plates were washed with phosphate buffered saline (PBS), pH 7.4, containing 0.05% Tween 80 (PBS/T), and the remaining binding sites were blocked with 1% bovine serum albumin, BSA, Sigma, in PBS (PBS/BSA). Next the serum samples diluted 1:40 and 1:80 in Tris-HCl pH 8.0 with 50 mM $CaCl_2$ (Tris-HCl/$CaCl_2$) supplemented with 1% BSA were added to the wells and the plates were incubated for 2 h, at 37°C. After washing, the plates were incubated for 2 h, at 37°C with rabbit antibodies against recombinant human MBL (rMBL), and then for 1 h with swine antibodies against rabbit immunoglobulins labelled with horseradish peroxidase-HRP (Dako, Glostrup, Denmark). The colour reaction was developed in the presence of substrate solution: 1 mg o-phenylenediamine dihydrochloride-OPD (Sigma) in 1 ml citric-acid phosphate buffer, pH 5.0 supplemented with 0.5 µl/ml of 30% H_2O_2. The reaction was stopped with citric acid and the absorbance was measured at 450 nm using Victor2 reader (Wallak, Oy, Turku, Finland). The standard curve was prepared by incubation of mannan-coated wells with a known amount of rMBL (0.073–1.2 µg/ml), and then with rabbit anti-rMBL antibodies and swine-HRP antibodies to rabbit immunoglobulins. In every ELISA the control wells were used for excluding the unspecific reactions.

Sera depleted in MBL. For phagocytosis assay two types of serum samples were used: 1) containing nMBL; 2) depleted in nMBL by absorption with *S. cerevisiae* mannan coated sepharose (Sigma, St. Louis, Michigan, USA) (Kase *et al*., 1991). In brief, 500 µl of mannan bound sepharose was sedimented by centrifugation for 2 min, 300 × g, and stabilized for 18 h, at 4°C with

Tris-HCl/$CaCl_2$. Equilibrated sepharose was centrifuged, then resuspended in 1 ml of serum containing 2 mM $CaCl_2$ and incubated for 30 min, at 4°C with agitation. After sedimentation of sepharose, the supernatant was collected for estimation of MBL concentration by ELISA, as described above.

Bacterial strains and culture conditions. The *H. pylori* reference strains 17 874 and 17 875 were obtained from the Culture Collection, University of Gothenburg (CCUG), Gothenburg, Sweden. Clinical isolates (31) were from dyspeptic children/adolescents and adults being under the care of Mother Health Center Institute and K. Jonscher Hospital in Łódź, Poland. The bacteria were stored at –70°C in tryptic soy broth containing 15% glycerol. Before being used in experiments the bacteria were cultured for 48 h, at 37°C in microaerophilic conditions on blood agar containing 10% heat inactivated fetal calf serum. The *Mycobacterium bovis* reference strain from Polish Bacterial Culture Collection was grown for 2–3 weeks at 37°C, 5% CO_2 on Middelbrook 7H9 medium (Difco, Detroit, Michigan, USA) containing 0.05% Tween 80 and ADC supplement (Becton Dickinson, Spartaks, USA).

Interaction of MBL with *H. pylori*. The interaction of MBL with *H. pylori* cells (33 strains) was estimated by ELISA assay on microplates coated for 18 h, at 4°C, with *H. pylori* and *M. bovis* (low binding control) bacterial suspensions, 1×10^7 cells/ml in PBS, pH 7.4 (100 µl/well). Positive ELISA control with rMBL coated wells (0.5 µg/ml) was also included. Unbound plastic was blocked with PBS/BSA. After washing the plates (once with PBS and three times with Tris-HCl/$CaCl_2$/ BSA) the rMBL (5 µg/ml in Tris-HCl/$CaCl_2$/BSA) was added to the wells (100 µl/well), and the plates were incubated for 2 h at 37°C. Next, the assay was continued as described above.

FITC labelling of *H. pylori* bacteria. The bacteria collected from the plates were washed once with PBS and resuspended in such buffer containing 100 µg/ml fluoresceine isothiocyanate (FITC). The mixture was agitated for 30 min at room temperature. The bacteria, after extensive washing with PBS, were resuspended with PBS containing 4% bovine serum albumin (BSA), to bind unconjugated FITC to BSA. After 15 min incubation at room temperature, the bacteria were washed and resuspended at 1×10^6 cell/ml in RPMI-1640 medium.

Phagocytosis. Polymorphonuclear leukocytes (PMNs) were separated from human fresh blood collected from healthy individuals by veinpuncture with heparin as an anticoagulant, by Polymorphoprep gradient centrifugation (Nycomed, Oslo, Norway). For phagocytosis, PMN suspensions (1×10^6 cells/ml) were prepared in 1ml volume of RPMI-1640 with gentamycin (5 µg/ml), containing: 1) 20% complete non-inactivated human serum containing 30 µg/ml of nMBL or 20% such serum with or without 10% rabbit anti-human rMBL antibodies; 2) 20% nMBL depleted serum; 3) 20% nMBL depleted serum and rMBL at a concentration of nMBL (30 µg/ml). The cells suspended in an appropriate medium were added in triplicate to the wells of microplate (100 µl/well) and supplemented with fluoresceine isothiocyanate (FITC)-labelled bacteria in RPMI-1640, at the ratio 1:10 or 1:100, and then incubated for 1h, at 37°C, 5% CO_2. Phagocytosis was stopped on ice. The unbound bacteria were removed by washing the cells with ice-cold PBS with gentamycin (PBS/G). The fluorescence was measured using Victor2 reader with 480/530 nm excitation/emission filters. Afterwards extracellular fluorescence was quenched with crystalline violet (500 µg/ml in PBS). The dye was exchanged with PBS/G. The intensity of fluorescence was measured as above, and expressed in relative fluorescence units (RFU) – fluorescence counts. The wells containing FITC labelled bacteria alone were used as control of quenching effectiveness. In each experiment a standard curve for quantitation of FITC labelled *H. pylori* bacteria was prepared. Serially diluted bacterial cell suspensions in RPMI-1640 medium, were distributed into the wells, and the fluorescence of bacteria was measured. The values of fluorescence were plotted as a function of the number of bacteria in each well (Chmiela *et al*., 1997).

Detection of C5b-C9 complement complexes. Activation of complement during phagocytosis was estimated immunoenzimatically by dot blot method using monoclonal antibodies against C5b-C9 complexes (Dako). Two microliters of post phagocytosis supernatants were dropped three times on the BA 85 membrane (Schleicher and Schuel, Dassel, Germany). After blocking with 2% BSA in Tris-HCl/200mM NaCl, pH 7.4 (Tris-HCl/NaCl/BSA) the membranes were incubated for 18 h, at room temperature with mouse monoclonal antibodies to C5b-C9 complex, diluted 1:40 in Tris-HCl/NaCl/BSA. After washing the membranes with Tris-HCl/NaCl containing 0.5% Tween 80, rabbit antibodies to mouse immunoglobulins labelled with HRP (diluted 1:1000 with Tris-HCl/NaCl/BSA) were added and the membranes were stored for 2 h at room temperature. The color reaction was developed using 1 ml of 4-chloro-1-naphtol (3 mg/ml, Sigma) mixed with 5 ml of Tris-HCl/NaCl (1:5) and with 30% H_2O_2 (0.5 µl/ml), and then stopped with H_2O. The appropriate controls excluding unspecific reactions were included into the study.

Statistics. Results were compared using the Statistica 5.5 PL program with unpaired Student's t-test and Chi-square χ^2 test. The difference was significant when $p < 0.05$.

Results

The level of MBL in *H. pylori* infected and uninfected individuals. There was a high variation in MBL amount in the serum samples in each group under the study (Table I). The MBL concentration was in the range 2–50 µg/ml. There was no significant difference in the frequency of the MBL concentration: 0–2 mg/ml; 2–4 µg/ml; 4–10 µg/ml and >10 µg/ml, between the groups of *H. pylori* infected and uninfected children/adolescents and adults or between males and females.

The interaction of *H. pylori* with MBL. The *H. pylori*-MBL interaction was evaluated for 31 clinical isolates and two reference strains. The results showed that all *H. pylori* strains interacted with rMBL when investigated by ELISA. The specific ELISA OD450 counts for *H. pylori* strains were in the range 1.0–2.0 (mean 1.5 ± 0.25) and for *M. bovis* 0.2–0.6 (mean 0.4 ± 0.05) (Table II). Positive ELISA counts for rMBL coated wells were in the range 0.8–1.0.

The intensity of phagocytosis of FITC-*H. pylori* bacteria by granulocytes in the presence or absence of MBL. The phagocytosis of MBL-binding *H. pylori* reference strain CCUG 17874 by human granulocytes,

Table I
The concentration of MBL in the sera from children/adolescents and adults infected or uninfected with *H. pylori*

Group investigated	Serum MBL concentration (μg/ml) Prevalence (%)				
	Range (**r**)	Below 2.0	**r**: 2.0–4.0	**r**: 4.0–10.0	>10.0
Children/adolescents *H. pylori* (+) mean: n = 69	**r** = 2.0–38.0 10.1 ± 9.0	12/69 (17%)	6/69 (9%)	24/69 (35%)	27/69 (39%)
H. pylori (–) n = 49 mean:	**r** = 2.0–49.6 12.2 ± 10.9	5/49 (10%)	6/49 (12%)	16/49 (33%)	22/49 (45%)
Adults *H. pylori* (+) n = 66 mean:	**r** = 2.0–30.5 9.6 ± 7.6	10/66 (15%)	8/66 (12%)	19/66 (29%)	29/66 (44%)
H. pylori (–) n = 40 mean:	**r** = 2.0 ± 43.2 10.4 ± 10.7	7/40 (18%)	6/40 (27%)	11/40 (27%)	16/40 (40%)

n – number of subjects

Table II
The interaction of recombinant mannose binding lectin (rMBL) with *H. pylori* and *M. bovis* estimated by ELISA

Bacterial strains	ELISA		
	Specific OD_{450} counts		Range of unspecific OD_{450} counts
	mean	range	
H. pylori	1.0 – 2.0	1.5 ± 0.25	0.1 – 0.4
M. bovis (low binding control)	0.2 – 0.6	0.4 ± 0.05	0.03 – 0.04
rMBL (positive ELISA control)	Range 0.8–1.0		

The interaction of rMBL with *H. pylori* and *M. bovis* was estimated by ELISA using *S. cerevisiae* mannan as coating antigen. Polyclonal rabbit anti-rMBL IgG were used for recognition of MBL bound with bacterial cells and swine antibodies against rabbit immunoglobulins labeled with horseradish peroxidase for detection of such complex.

Table III
The intensity of phagocytosis of FITC-labelled *H. pylori* bacteria by human granulocytes in the presence or absence of natural (nMBL) or recombinant mannose binding lectin (rMBL) and anti-rMBL antibodies

Phagocytosis milieu							
supplemented with: 20% serum containing 30 μg/ml nMBL (control culture)		supplemented with: 20% nMBL-depleted serum		supplemented with: 20% serum containing 30 μg/ml nMBL and anti-rMBL rabbit IgG		supplemented with: 20% nMBL depleted serum and 30 μg/ml rMBL	
Fluorescence counts	Phagocytosis index	Fluorescence counts	Phagocytosis index	Fluorescence counts	Phagocytosis index	Fluorescence counts	Phagocytosis index
1284	1.0	1940	1.5	3372	2.6	2848	2.2
1048		5707	5.4	4578	4.3	1125	1.0
1486		4169	2.8	6180	4.1	1161	0.8
2560		6074	2.3	5759	2.2	2926	1.1
Mean: 1595 ± 668	1.0	Mean: 4473 ± 1879	Mean: 3.0	Mean: 4972 ± 1264	Mean: 3.3	Mean: 2015 ± 1008	Mean: 1.3

The ingestion of *H. pylori*-FITC labeled bacteria by granulocytes was estimated fluorimetrically. The intensity of phagocytosis was expressed as mean of the fluorescence counts from four experiments, evaluated in the fluorescence reader Victor^2. The phagocytosis index was calculated with relation to the intensity of phagocytosis in the medium supplemented with 20% of serum containing 30mg/ml nMBL (control culture).
→ Difference statistically significant ($p < 0.05$).

in the medium with 20% of complete human serum containing natural MBL-nMBL (30 μg/ml), was expressed as relative fluorescence units – RFU (1595 ± 668) and as Phagocytosiss Index 1.0 (Table III). The replacement of the complete serum by the same serum depleted in nMBL (nMBL-depleted serum) on mannan coated sepharose caused a significant ($p < 0.05$) increase of fluorescence counts from 1595 ± 668 to 4473 ± 1879 and Phagocytosis Index up to 3.0. The preservation of complement activity in MBL--depleted serum was proved by using monoclonal anti-C5-C9 complex antibodies. Data in Table III also show that addition of rabbit IgG against recombinant MBL (rMBL) to the phagocytosis samples with human complete serum containing natural MBL increased the fluorescence counts from 1595 ± 668 to 4972 ± 1264 and Phagocytosis Index from 1.0 to 3.3. The replenishment of removed human serum by the addition of rMBL did not cause the increase of phagocytosis intensity (RFU 2015 ± 1008, Phagocytosis Index 1.3) as compared with the intensity of ingestion in the medium with nMBL (RFU 1595 ± 668, Phagocytosis index 1.0).

Discussion

Previously we showed that interaction between *H. pylori* surface structures, namely sialic acid-specific haemagglutinin or heparin/heparan sulfate binding proteins, and corresponding macrophage receptors is required for engulfment of *H. pylori* bacteria. On the other hand, these microbes can use host's sialylated compounds, heparin/heparan sulfate glycosaminoglycans, hyaluronic acid or vitronectin in the presence of complement to escape phagocytosis (Chmiela *et al*., 1998; Drogari-Apiranthitou *et al*., 1997; Rudnicka *et al*., 1998, 2001).

In this study we found that all *H. pylori* strains bound recombinant MBL as estimated by ELISA. These bacteria bound MBL more intensively than the cells of *M. bovis*. Fungi of *Candida* species and *Aspergillus fumigatus* as well as bacteria *Staphylococcus aureus*, exhibited strong binding of MBL, whereas *Escherichia coli*, *Klebsiella* spp., and *Haemophilus influenzae* type b were characterized by heterogenous binding patterns (Neth *et al*., 2000). In contrast, beta-haemolytic group B streptococci, *S. pneumoniae* and *S. epidermidis* showed low levels of binding. The MBL binding by *H. pylori* could be mediated by mannose residues in various bacterial cell surface structures but also by fucose moieties of Lewis X or Lewis Y determinants present in the LPS of the majority of *H. pylori* strains (Moran *et al*., 1996). Jack *et al*. (2001) and Devyatyarnova-Johanson *et al*. (2000), showed that bacterial LPS was of major importance in determining the binding of MBL to Gram-negative organisms *Salmonella* spp. and *Neisseria* spp.

In general, it is thought that MBL mediates protection against infections due to its opsonic activity, by activating the complement system in the presence of MASP (Garred *et al*., 2003; Matsushita and Fujita, 1992). However, in this study the *H. pylori* bacteria were ingested more intensively by human granulocytes in the medium with MBL-depleted or anti-MBL sera as compared with the intensity of phagocytosis in the medium with complete fresh sera containing natural MBL (nMBL). The complement was possibly involved in this process. During phagocytosis, in the presence of complete serum, the lytic complex could be generated on lectin pathway due to the interaction of nMBL with *H. pylori* bacteria. In the post-phagocytosis supernatants the C5b-C9 terminal complement complex was detected. The lysis due to complement could diminish the number of ingested bacteria in the milieu of nMBL. The complement could be activated on lectin pathway both in the medium with or without nMBL, by serum ficolins which may bind mannose or GlcNAc present on the surface structures of *H. pylori* (Holmskov *et al*., 2003; Matsushita *et al*., 2001). During the depletion of the sera in nMBL the activity of C5b-C9 complex was preserved. The mechanism of antibody blocking of the MBL inhibition of phagocytosis could be through blocking of nMBL binding to *H. pylori* or blocking of its inhibiting qualities. The interaction of anti-MBL IgG with nMBL bound to mannose residues on the surface of granulocytes or binding of nMBL-anti-nMBL IgG complexes to phagocyte Fc receptors could not be excluded. Another explanation for diminished phagocytosis of *H. pylori* in the medium containing nMBL as compared to the medium without nMBL is that bacteria avoid phagocytosis by intensive nMBL binding, a phenomenon which was earlier observed by us for vitronectin and sialic acid (Chmiela *et al*., 1998). MBL may mask the *H. pylori* surface adhesins important for recognition and engulfment of these bacteria by phagocytes. A weak *H. pylori* phagocytosis in nMBL-depleted serum with rMBL confirms this suggestion. The more extreme environment for MBL binding in the gastric mucosa, where phagocytic cells infiltrate during infections, can be neutralized by *H. pylori* urease. Similarly, to the results of our study, Swanson *et al*. (1998), showed the 50% inhibition of the interaction of *Chlamydia trachomatis*, *C. pneumoniae* and *C. psittaci* with the leukocytes by rMBL.

Considering the known role of phagocyte receptors for Fc fragment of IgG (FcγR) in the ingestion of bacteria it was interesting to compare the outcome of *H. pylori* phagocytosis in the medium with the sera from *H. pylori* infected individuals, seropositive for anti-*H. pylori* IgG and from uninfected, seronegative donors. In this study, we could see no difference in the ingestion of MBL-binding *H. pylori* bacteria in the medium with sera containing or free of anti-*H. pylori* IgG. Similarly, we observed no significant difference in the MBL levels in the sera from *H. pylori* infected or uninfected children and adults. Also Klabunde *et al*. (2000), showed no differences in serum MBL concentration in the patients infected with *Schistosoma* sp. and in healthy controls though *Schistosoma* cercariae and adult worms, like *H. pylori*, bind MBL. In contrast, MBL deficiencies were detected with a high frequency in the patients infected with HIV, hepatitis B virus or *Neisseria meningitides* (Devyatyarnova-Johanson *et al*., 2000; Saifuddin *et al*., 2000; White *et al*., 2000). The lack of significant correlation between MBL concentration and *H. pylori* infection in this cohort study implies that MBL is not an essential factor in the disease process. However, in some *H. pylori* infected patients, the elevated MBL concentration by blocking *H. pylori* phagocytosis may allow these bacteria permanent colonization of gastric mucosa. In the summary, our results indicate that *H. pylori* bacteria may use MBL to avoid engulfment by phagocytes. The interactions of bacterial compounds and host lectins may regulate *H. pylori* phagocytosis and on this way influence an outcome of *H. pylori* related infections.

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