Humoral Immune Response to Conserved Epitopes of *Chlamydia trachomatis* and Human 60-kDa Heat-Shock Protein in Women with Pelvic Inflammatory Disease


The association between humoral immunity to unique and conserved epitopes of the *Chlamydia trachomatis* 60-kDa heat-shock protein (hsp60) and immunity to human hsp60 was examined in 129 women with laparoscopically verified pelvic inflammatory disease. An ELISA was used to detect antichlamydial IgG and IgA antibodies, IgG antibodies to recombinant human hsp60, and antibodies to two synthetic peptides of chlamydial hsp60. Half of the patients had antibodies to human hsp60, which correlated with the presence of antibodies to the chlamydial hsp60 peptide 260–271 homologous to the human hsp60 (*P* < .01). Antibodies to peptide 260–271 were associated with antichlamydial IgG (*P* < .0001) and IgA (*P* < .0001). The results suggest that the autoimmune response to human hsp60 can develop following *C. trachomatis* upper genital tract infection in women, probably as a consequence of an immune response to an epitope of chlamydial hsp60 cross-reactive with the human hsp60.

*Chlamydia trachomatis* causes a number of sexually transmitted diseases, including cervicitis, pelvic inflammatory disease (PID), urethritis, epididymitis, and lymphogranuloma venereum. Subsequent chronic inflammatory changes and fibrosis may lead to infertility and ectopic pregnancy [1, 2]. Earlier studies suggested that two-thirds of the cases of tubal infertility and one-third of the cases of ectopic pregnancy were caused by an earlier episode of chlamydial salpingitis [3, 4].

The persistent (and, if untreated, recurrent) nature of chlamydial infections provides an opportunity for chronic stimulation of the host immune system with chlamydial antigens. The 60-kDa heat-shock protein (hsp60) has been particularly implicated in the induction of *Chlamydia*-related immunologic damage [5]. The chlamydial hsp60, expressed 2–26 h after infection [6], is partially homologous with its counterpart GroEL in *Escherichia coli* and with the human hsp60 [7].

Involvement of the chlamydial hsp60 in the pathogenesis of *C. trachomatis*–associated ectopic pregnancy [8, 9] and tubal infertility [3, 9, 10] has been demonstrated. Those with high antibody titers to chlamydial hsp60 among women with laparoscopically visualized chlamydial PID have significantly more severe tubal alterations [11].

Extensive amino acid sequence homology between chlamydial and human hsp60 [5] suggests that a chronic *C. trachomatis* infection of the fallopian tubes may lead to an autoimmune response directed against conserved epitopes expressed in the human hsp60. Antibodies to some epitopes of chlamydial hsp60 also bind to homologous peptide sequences in human hsp60 [12–14]. Tubal occlusion in patients with immunity to conserved hsp60 epitopes may, therefore, be at least partially due to an autoimmune response to human hsp60 induced in the tubal mucosa [15, 16]. Detection of antibodies to chlamydial hsp60 that also react with human hsp60 might provide a predictive marker for patients at risk for developing tubal damage after *C. trachomatis* infections [17].

At present, there is no indication that production of antibody to hsp60 is disease-specific; rather, it is thought to be related to chronicity of inflammation. Antibodies to *C. trachomatis* hsp60 have been demonstrated in 84% of seropositive women with tubal and in 33% with non–tubal factor infertility [3], in 31% of women with PID, in 17% of patients with ectopic pregnancy [9], and in 9% of healthy *Chlamydia*-seropositive controls [3].

The aim of the study was to investigate whether humoral immunity to a synthetic peptide corresponding to a B cell epitope of chlamydial hsp60 is associated with the presence of antibodies to human hsp60, by testing sera from women with PID.

**Materials and Methods**

*Study population.* The study population consisted of 129 women attending the University Hospital in Helsinki (Finland) and the Gynaecological Clinic in Kaunas (Lithuania), with laparoscopically verified PID.

*Diagnostic criteria for PID.* The clinical diagnosis of PID was established if women attended with a history of lower abdominal pain (<3 weeks) and if, at the time of attendance, they experienced...
uterine and bilateral adnexal tenderness and had an elevated C-reactive protein concentration (>10 g/L). Women with clinical diagnosis of PID underwent laparoscopy. Only sera from patients with laparoscopically proven PID were selected for the study.

**Questionnaire.** Women were asked about the history of previous genital infections.

**Diagnosis of genital infection by C. trachomatis.** Cervical and urethral swabs were collected and tested by EIA (Chlamydiazyme; Abbott Laboratories, Abbott Park, IL; MicroTrak Chlamydia trachomatis EIA; Behring, San Jose, CA). Positive EIA results were confirmed by direct immunofluorescence (MicroTrak Chlamydia trachomatis Direct Specimen Test; Behring).

**Serum samples.** Blood serum samples were obtained at the time the patient was evaluated for acute PID as described earlier [18] and kept at −70°C until investigated.

**Detection of antibodies to chlamydial lipopolysaccharide (LPS).** An ELISA used to detect antibodies directed against synthetic glycoconjugate epitopes of chlamydial LPS was done as described earlier [19], with modification [20]. Sera were titrated at 2-fold dilutions, from 1:50 to 1:12,500 for detection of IgA (cIgA-LPS) and IgM (cIgM-LPS) and from 1:100 to 1:25,600 for IgG (cIgG-LPS) C. trachomatis antibodies.

**Detection of antibodies against chlamydial hsp60.** Antibodies against two synthetic peptides of chlamydial hsp60, corresponding to aa 151–162 and 260–271 in the hsp sequence, were detected by ELISA. Antibodies to peptide 260–271 react with the homologous peptide in human hsp60, demonstrating that this amino acid sequence is conserved between Chlamydia species and humans. In contrast, humoral immunity to peptide 151–162 was unique; antibodies to this epitope were nonreactive with the corresponding human hsp60 sequence [14]. Microtiter plates (Maxisorp Immunoplate; Nunc, Roskilde, Denmark) were precoated with 5 mg/mL streptavidin (Sigma, St. Louis), which was allowed to evaporate overnight at room temperature, and then incubated for 1 h at room temperature with 10 mg/mL biotinylated peptide diluted in 0.1% bovine serum albumin (BSA)/PBS with 0.1% NaNO₃. After washing, 0.1 mL of sera diluted 1:50 in 2% BSA/PBS and 0.1% NaNO₃ was added to the wells and incubated at 37°C for 2 h. After washing, a goat anti-human IgG labeled with horseradish peroxidase (Kirkegaard & Perry Laboratories, Gaithersburg, MD) was diluted 1:200 in 2% BSA/PBS and incubated for 1 h at room temperature. After final washing, ABTS substrate (Sigma) was added. The optical densities of each plate were read at 405 nm, with an autoreader (MicroTrak EIA; Syva, Palo Alto, CA).

**Detection of antibodies to human hsp60.** Recombinant human hsp60 (StressGen, Victoria, Canada) was diluted to 10 µg/mL in 0.1 M carbonate buffer, pH 9.8, and 0.1 mL was added to microtiter plate wells. After overnight incubation at 4°C, the wells were washed four times with PBS–TWEEN 20 (PBS-T). Aliquots (0.1 mL) of sera diluted 1:200 in PBS-T were added to the wells, and the plate was floated on a 37°C water bath for 60 min. The wells were then washed and incubated with a 1:200 dilution of alkaline phosphatase–conjugated goat antibody to human IgG. After an additional 60-min incubation at 37°C, the wells were washed as described above, and the colorless alkaline phosphatase substrate, p-nitrophenylphosphate in 10% diethanolamine buffer, was added. After incubation at room temperature for 30–60 min, the plates were read at 405 nm.

Known positive and negative samples were always assayed in parallel with the test samples. Sera from 50 women of reproductive age without known fertility problems and no history of abortions or genital tract infections were tested as controls for IgG antibody to human hsp60. The mean optical density (OD) value was 0.485 (SD, 0.148). A positive sample was defined as one yielding an OD value that was at least 2 SD above the mean value obtained with a panel of samples from control subjects, that is, an OD at 405 nm >0.780 (mean ± 2 SD of the controls). The mean ± SD for the PID patients positive for anti–human hsp60 was 1.240 ± 0.340. The mean ± SD for PID patients negative for anti–human hsp60 was 0.539 ± 0.134.

**Statistical analysis.** Any difference between groups of data was calculated by the χ² test and Student’s t test as well as by using odds ratios with 95% confidence intervals. The JMP program for Macintosh (SAS Institute, Cary, NC) was used.

**Results**

cIgG-LPS and cIgA-LPS antibodies were detected in 75.9% (98/129) and 59.7% (77/129) of the women with PID, respectively. The mean titer of cIgG-LPS antibodies was 1:1837, while the mean titer of cIgA-LPS antibodies was 1:358. No cIgM-LPS antibodies were found (table 1).

**Table 1. Distribution of IgG (cIgG-LPS) and IgA (cIgA-LPS) antibodies to chlamydial lipopolysaccharide, human hsp60, and antibodies to chlamydial hsp60 peptides 151–162 and 260–271 in 129 women with pelvic inflammatory disease.**

<table>
<thead>
<tr>
<th>Antibodies to</th>
<th>Chlamydial hsp60</th>
<th>Chlamydial hsp60</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>peptide 151–162</td>
<td>peptide 260–271</td>
</tr>
<tr>
<td>No. (%)</td>
<td>cIgG-LPS</td>
<td>cIgA-LPS</td>
</tr>
<tr>
<td>13 (10)</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>1 (0.8)</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>2 (1.6)</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>5 (3.9)</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>1 (0.8)</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>2 (1.6)</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>7 (5.4)</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>2 (1.6)</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>1 (0.8)</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>3 (2.3)</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>17 (13.2)</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>6 (4.7)</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>4 (3.1)</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>5 (3.9)</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>16 (12.4)</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>11 (8.5)</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>18 (14.0)</td>
<td>+</td>
<td>+</td>
</tr>
</tbody>
</table>

Total no. (%) 98 (76) 77 (59.7) 73 (56.6) 41 (31.8) 51 (39.5)
Table 2. Presence of IgG (clgG-LPS) and IgA (clgA-LPS) antibodies to recombinant chlamydial lipopolysaccharide, human hsp60 (hhsp60), and synthetic chlamydial hsp60 (chsp60) peptides 151–162 and 260–271 in 129 women with pelvic inflammatory disease with and without genital *C. trachomatis* infection.

<table>
<thead>
<tr>
<th>Antibodies</th>
<th>Present (n = 75)</th>
<th>Absent (n = 54)</th>
<th>P</th>
<th>OR</th>
<th>95% CI</th>
</tr>
</thead>
<tbody>
<tr>
<td>clgG-LPS</td>
<td>69 (53.5)</td>
<td>29 (22.5)</td>
<td>&lt;.001</td>
<td>9.9</td>
<td>3.9–29</td>
</tr>
<tr>
<td>clgA-LPS</td>
<td>45 (42.0)</td>
<td>23 (17.8)</td>
<td>&lt;.001</td>
<td>3.5</td>
<td>1.7–7.4</td>
</tr>
<tr>
<td>IgG hhsp60</td>
<td>47 (36.4)</td>
<td>26 (20.1)</td>
<td>.07</td>
<td>1.8</td>
<td>0.8–3.7</td>
</tr>
<tr>
<td>IgG chsp60 peptide 151–162*</td>
<td>31 (24.0)</td>
<td>10 (7.6)</td>
<td>&lt;.01</td>
<td>3.0</td>
<td>1.4–7.4</td>
</tr>
<tr>
<td>IgG chsp60 peptide 260–271†</td>
<td>39 (30.2)</td>
<td>12 (9.3)</td>
<td>&lt;.001</td>
<td>3.8</td>
<td>1.8–8.6</td>
</tr>
</tbody>
</table>

NOTE. Data are no. (%). OR, odds ratio; CI, confidence interval.

*Chlamydia*-specific.

†Cross-reacts with human hsp60.

IgG antibodies to synthetic peptides corresponding to aa 151–162 and 260–271 of the chlamydial hsp60 were present in 41 (31.8%) and 51 (39.5%) of the women, respectively. IgG antibodies to human hsp60 were detected in sera of 73 (56.6%) patients.

At the time the blood sample was drawn, 51% of the 129 women harbored *C. trachomatis* antigen in the cervix or urethra. Both clgG-LPS and clgA-LPS antibodies were detected more often in patients with genital *C. trachomatis* infection (*P < .001* for each). The same was true for antibodies to synthetic peptides 151–162 and 260–271 (*P < .01* and *P < .001*, respectively). However, there was no difference between *C. trachomatis*–positive and –negative women in the rate of antibodies to human hsp60 (table 2).

The relation between clgG-LPS and clgA-LPS antibodies and antibodies to human hsp60 and two chlamydial hsp60 synthetic peptides is shown in table 3. Women with clgG-LPS or clgA-LPS antibodies did not more often have antibodies to human hsp60 or chlamydial hsp60 peptide 151–162. However, women having clgG-LPS or clgA-LPS antibodies had antibodies to chlamydial hsp60 peptide 260–271 significantly more often than did those who did not harbor clgG-LPS or clgA-LPS antibodies in their sera: 48% versus 13% and 52% versus 21% (*P = .001*).

Women with clgG-LPS antibodies harbored antibodies to both chlamydial hsp60 peptides (*P = .03*), as well as to both human hsp60 and chlamydial hsp60 peptide 260–271 (*P = .001*), significantly more often than did women without such antibodies. Antibodies to both human hsp60 and chlamydial hsp60 peptide 260–271 were also more often observed in women with than in women without clgA-LPS antibodies (*P = .002*) (table 3).

Presence of IgG antibodies to chlamydial hsp60 peptide 260–271 correlated with the presence of antibodies to human hsp60.

Table 3. IgG antibodies to human hsp60 (hhsp60) and synthetic chlamydial hsp60 (chsp60) peptides 151–162 and 260–271 in 129 women with pelvic inflammatory disease with and without IgG (clgG-LPS) and IgA (clgA-LPS) antibodies to recombinant chlamydial lipopolysaccharide.

<table>
<thead>
<tr>
<th>IgG antibodies to</th>
<th>Positive (n = 98)</th>
<th>Negative (n = 31)</th>
<th>P</th>
<th>OR</th>
<th>95% CI</th>
<th>Antibodies to clgG-LPS</th>
<th>Positive (n = 77)</th>
<th>Negative (n = 52)</th>
<th>P</th>
<th>OR</th>
<th>95% CI</th>
</tr>
</thead>
<tbody>
<tr>
<td>hhsp60 (n = 73)</td>
<td>58 (59.2)</td>
<td>15 (48.4)</td>
<td>.2</td>
<td>1.5</td>
<td>0.7–3.5</td>
<td>45 (58.4)</td>
<td>28 (53.9)</td>
<td>.4</td>
<td>1.2</td>
<td>0.6–2.5</td>
<td></td>
</tr>
<tr>
<td>chsp60 peptide 151–162* (n = 41)</td>
<td>34 (34.7)</td>
<td>7 (22.6)</td>
<td>.1</td>
<td>1.8</td>
<td>0.7–4.7</td>
<td>27 (35.0)</td>
<td>14 (27.0)</td>
<td>.2</td>
<td>1.5</td>
<td>0.6–3.2</td>
<td></td>
</tr>
<tr>
<td>chsp60 peptide 260–271† (n = 51)</td>
<td>47 (48.0)</td>
<td>4 (13.0)</td>
<td>&lt;.001</td>
<td>6.2</td>
<td>2.2–22.2</td>
<td>40 (52.0)</td>
<td>11 (21.2)</td>
<td>&lt;.001</td>
<td>4.0</td>
<td>1.9–9.3</td>
<td></td>
</tr>
<tr>
<td>chsp60 peptides 151–162 and 260–271 (n = 30)</td>
<td>27 (28)</td>
<td>3 (10)</td>
<td>.03</td>
<td>3.5</td>
<td>1.1–15.7</td>
<td>22 (28.6)</td>
<td>8 (15.4)</td>
<td>.06</td>
<td>2.2</td>
<td>0.9–5.7</td>
<td></td>
</tr>
<tr>
<td>hhsp60 and chsp60 peptide 151–162* (n = 27)</td>
<td>22 (23)</td>
<td>5 (16)</td>
<td>.3</td>
<td>1.5</td>
<td>0.5–4.9</td>
<td>18 (23.4)</td>
<td>9 (17.3)</td>
<td>.2</td>
<td>1.5</td>
<td>0.6–3.7</td>
<td></td>
</tr>
<tr>
<td>hhsp60 and chsp60 peptide 260–271† (n = 36)</td>
<td>34 (35)</td>
<td>2 (7)</td>
<td>.001</td>
<td>7.7</td>
<td>2.1–49.4</td>
<td>29 (37.7)</td>
<td>7 (13.5)</td>
<td>.002</td>
<td>3.9</td>
<td>1.6–10.4</td>
<td></td>
</tr>
</tbody>
</table>

NOTE. Data are no. (%). OR, odds ratio; CI, confidence interval.

*Chlamydia*-specific.

†Cross-reacts with human hsp60.
hsp60. Human hsp60 IgG antibodies were found in 70.6% (36/51) of women with versus 47.4% (37/78) of women without such antibodies (P = .01). Women with antibodies to this peptide also more often had cIgG-LPS antibodies (P = .001; 92% [47/51] vs. 65% [51/78]) and cIgA-LPS antibodies (P = .001; 78% [40/51] vs. 47% [37/78]). Such correlation, however, was not observed in women with antibodies to chlamydial hsp60 peptide 151–162 (P > .1).

Significantly more women (P > .00) with than without antibodies to chlamydial hsp60 peptide 151–162 also harbored antibodies to chlamydial hsp60 peptide 260–271: 76% (31/41) versus 23% (20/88). The same was observed in women having antibodies to peptide 260–271; that is, significantly more of them also had developed antibodies to chlamydial hsp60 peptide 151–162 than did those who did not have such antibodies (60% [31/51] vs. 13% [10/78]; P = .00).

Subjects with IgG antibodies to the human hsp60 more often had IgG antibodies to chlamydial hsp60 peptide 260–271 (P = .001; 49% [36/73] vs. 27% [15/56]) but not to chlamydial hsp60 peptide 151–162 or chlamydial LPS (P = .2 and .4, respectively).

There was no correlation between titers of cIgG-LPS nor cIgA-LPS antibodies and OD for synthetic peptides 151–162 or 260–271 or human hsp60 in ELISA (data not shown).

**Discussion**

Seventy-six percent of women with laparoscopically diagnosed PID had serologic evidence of chlamydial infections, as demonstrated by rLPS-ELISA. However this test detects only genus-specific antibodies, and therefore, it is possible that in some of the patients, antibodies to another chlamydial species, such as *Chlamydia pneumoniae*, were also detected. We have previously demonstrated that 61% of the patients with PID and 61% of women with fertility problems had antibodies to *C. trachomatis*. However, 68% and 84% of such patients also harbored antibodies to *C. pneumoniae* [18], a common respiratory tract pathogen [21].

hsp60 comprises an extensive group of compounds involved in the biogenesis of proteins from the time of synthesis until the assembly of multimeric complexes [22]. They are phylogenetically conserved and have 60% sequence homology with eucahyotic hsp60, 50% homology with bacterial hsp60, and 80% homology with *C. trachomatis* serovars [17]. The presence of this protein may elicit a delayed-type hypersensitivity response [5]. The homology between bacterial and human hsp60 and also the fact that human hsp60 may be increased locally at the site of infection may indicate a role for hsp60 autoimmune in the immunopathogenicity of chlamydial infections [23]. We have demonstrated that sensitization to human hsp60 is associated with humoral immune response to a conserved epitope of the chlamydial hsp60 in patients with PID and serologic evidence of exposure to chlamydiae. This suggests that an autoimmune response to human hsp60 may arise as a consequence of a *C. trachomatis* upper genital tract infection in those women who develop sensitivity to chlamydial hsp60 epitopes that cross-react with epitopes of the human hsp60.

In another study, anti-hsp antibodies occurred more frequently in women with completely occluded tubes having both *C. pneumoniae* and *C. trachomatis* antibodies [24]. However, in this study, we did not perform the microimmunofluorescence test, which differentiates antibodies to different chlamydial species. It is possible that highly prevalent *C. pneumoniae* infections might enhance the anti-hsp response in patients with a history of *C. trachomatis* infections.

The low prevalence of antibodies to the chlamydial hsp peptide 151–162 compared with antibodies to peptide 260–271 suggests that the former epitope may be less immunogenic.

The lack of a relationship between antibodies to chlamydial LPS and to peptide 151–162 also supports this. Although anti-hsp peptide 260–271 IgG was highly associated with cIgG-LPS and cIgA-LPS antibodies, some women with antibodies to this synthetic chlamydial hsp60 peptide were negative for IgG antibodies to chlamydial LPS. This suggests that, in some women with PID, chlamydial hsp60 may be preferentially expressed or that this protein more readily induces an immune response than does LPS [3, 8, 9].

Prevalence of IgA, but not IgM, antibodies indicated that we were dealing with chronic rather than acute infection. Our previous study, conducted on patients with sexually acquired reactive arthritis, demonstrated that antibodies to chlamydial LPS are more frequently found in patients with recent disease [20]. This would explain the lack of association between antibodies to chlamydial hsp60 and LPS in some of the patients.

On the other hand, production of chlamydial hsp60 antibodies may also dominate over antibodies to another antigenic compound of chlamydiae—major outer membrane protein (MOMP)—which plays a major role in protective immunity against infection. Women with high responses to chlamydial hsp60 but weak responses to MOMP, that is, low antibody titers as detected by microimmunofluorescence, are at increased risk of developing PID if repeatedly exposed to *C. trachomatis* [11].

Another possibility is that in women without demonstrable antibodies to chlamydial LPS, the initial hsp60-related immunogen was a microorganism other than *C. trachomatis*. The high degree of amino acid sequence conservation between microbial hsps [17] then may lead to production of antibodies that recognize the hsp60 amino acid sequence also present in chlamydial hsp60.

Antibody responses to human hsp60 were observed in 56% of women with PID, which is in line with findings in *C. trachomatis*–associated ectopic pregnancy cases [14]. We also found that significantly more women having antibodies to chlamydial LPS also had serum antibodies against both the conserved synthetic chlamydial hsp60 peptide 260–271 and human hsp60. Immune recognition of hsp60 may incite an autoimmune reaction through molecular mimicry [25]. Alternatively, antibody responses to chlamydial hsp60 may signal persistent or
recurrent chlamydial infection with other chlamydial antigens of the same [26] or other chlamydial species [24], sustaining the chronic inflammatory reaction. Cervical IgA antibodies to peptide 260–271 also correlated with early-stage pregnancy loss in women undergoing in vitro fertilization [27].

Chlamydial infections are often asymptomatic and might therefore remain untreated. Resulting persistent and recurrent infections provide an opportunity for chronic stimulation of the host’s immune system. In addition, hsp60 may also be produced during subclinical infection [26]. The ratio between chlamydial hsp60 and MOMP increases dramatically after such chlamydial infection in vitro [28]. Our study demonstrated that in women with PID, genital C. trachomatis infection stimulates production of antibodies to chlamydial LPS and hsp. Presence of such antibodies strongly correlated with the presence of chlamydial antigen in the genital tract.

Experimental C. trachomatis infection in monkeys, multiply infected with the agent, has also demonstrated that the presence of antibodies to chlamydial hsp60 was related to the presence of chlamydial nucleic acid in fallopian tubes and/or the cervix [29]. On the contrary, no association between ongoing genital infection and the presence of chlamydial hsp60 antibodies was found in women with PID, when C. trachomatis was cultured from fallopian tubes [30]. The difference in the results might be explained by the different methods used to detect C. trachomatis infection. It is known that isolation of C. trachomatis from fallopian tubes is difficult, partially because of the toxic substances present in the sample [31]. On the other hand, it may suggest that antigenic stimulation (production of hsp antibodies) is caused by dead microorganisms.

Increased hsp60 expression in persons with chronic infection might contribute to the delayed-type hypersensitivity reaction characterizing the severe sequelae of chlamydial infections: tubal damage [32] or scarring in trachoma [33]. hsp60 contact with mucosal surfaces elicits intense inflammatory responses [34].

The present study suggests that in susceptible women, induction of immune response to a conserved epitope of the chlamydial hsp60 can also lead to an autoimmune response to human hsp60. This can exacerbate a local inflammatory response that can further damage the integrity of the fallopian tubes.

Acknowledgment

We gratefully acknowledge Helmut Brade for providing laboratory facilities and necessary reagents to perform the LPS-ELISA.

References


