Glycogen Assay for Diagnosis of Female Genital Chlamydia trachomatis Infection

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Chlamydia trachomatis can synthesize glycogen at various stages in its developmental cycle. The glycogen content of female genital epithelial cells was detected by anthrone, and the results were compared with those from PCR. A total of 320 cervical samples were examined. Of 92 specimens that were positive by PCR, 78 were positive and 14 were negative by the glycogen assay. Of 228 specimens that were negative by PCR, 220 were negative and 8 were positive by the glycogen assay. The sensitivity and specificity of the glycogen assay obtained from these data were 84.8% (78 of 92) and 96.5% (220 of 228), respectively. Use of the glycogen assay to detect the glycogen content in genital epithelial cells may be helpful in the diagnosis of C. trachomatis infection. This is an easy, fast, and inexpensive assay and can be done in less-sophisticated labs.

MATERIALS AND METHODS

Clinical specimens. A total of 320 specimens were collected from the Outpatient Department of No. 1 Affiliated Hospital of our university between March 1996 and June 1997 by exposing the cervix, wiping away cervical secretions with swabs, scraping epithelial cells, and placing them into sterilized saline in duplicate.

PCR. Primers of plasmid PCTT1 of C. trachomatis were synthesized by Shanghai Shisheng Bio-technological Corporation (Shanghai, People’s Republic of China). The nucleotide sequences of primer set 5’-GTT TAA GTG TTC CCA TCA TAA AAA CAT ATTC-3’ and 5’-ATC CTT GTA TCC TGT TGG GAA GCC ATC AAAG-3’ covered a 503-base portion of plasmid PCTT1 of C. trachomatis (4). Clinical specimens were washed, and the cells were suspended in 250 ml of Tris-HCl buffer containing 50 μg of proteinase K per ml, 0.45% sodium dodecyl sulfate, and 1 ml of 0.2% anthrone (0.2 g of anthrone in 100 ml of 98% H2SO4, g/ml), prepared freshly in 1 l) were added, and the vials were placed in boiling water for 20 min. The optical density (OD) at 620 nm of the solution in vials was determined by photometry.

The ODs of glucose at different concentrations (50, 25, 12.5, 6.25, 3.12, and 1.6 μg/ml) were 0.88, 0.4, 0.26, 0.10, and 0.05, respectively. This method could detect 1.6 μg of glucose per ml, which was equivalent to 1.44 μg of glycogen per ml (7).

Because glycogen is insoluble in ethanol, it can be precipitated in anhydrous ethanol. Glycogen is dehydrated by 98% H2SO4 in order to produce furfural derivatives, which then produce a blue compound after reacting with anthrone. The OD of the color compound can be determined by photometry (7).

Glucose curve. A fixed weight of glucose was diluted in series, and anthrone was added to determine the ODs of glucose at different concentrations.

Methods for calculating the sensitivity and specificity of the glycogen assay. The sensitivity of the glycogen assay was calculated as the number of samples positive by the glycogen assay as well as positive by PCR divided by the number of samples positive by PCR. The specificity of the glycogen assay was calculated as the number of samples negative by the glycogen assay as well as negative by PCR divided by the number of samples negative by PCR.

RESULTS

Of 320 cervical samples, 92 were positive and 228 were negative by PCR. The rate of positivity was 28.8%. The distribution of ODs in the glycogen assay was from 0 to 1.0 (Fig. 1). The mean OD of specimens positive by PCR was 0.6, and the mean OD of the specimens negative by PCR was 0.09. The results showed that the mean OD of the PCR-positive group was remarkably higher than that of the negative group (P < 0.0005). A result by the glycogen assay was considered positive when the ODs of specimens were equal to or higher than 0.3. Of 92 specimens positive by PCR, 78 were positive and 14 were negative by the glycogen assay. Of 228 specimens negative by PCR, 220 were negative and 8 were positive by the glycogen assay. The sensitivity and specificity of the glycogen assay obtained from these data were 84.8% (78 of 92) and 96.5% (220 of 228), respectively.

DISCUSSION

C. trachomatis not only can cause male and female urogenital infections but can also endanger fetal and infant health by vertical transmissions of infections during pregnancy, resulting in abortion, infants with abnormally low weight, newborn pneumonia, or conjunctivitis, etc. (7). There are two kinds...
of urogenital infections with *C. trachomatis*: (i) persistent infections, in which the pathogen is latent in cells, causing no obvious symptoms; and (ii) symptomatic infections, in which the pathogen is reproductive in cells, causing obvious symptoms. Laboratory examinations, such as cell culture, immunofluorescence, immunoenzyme assays, and PCR, etc., are currently the major methods to diagnose *C. trachomatis* infections. They are complicated, time-consuming, limited by equipment, and difficult to be applied to basic medical units.

*C. trachomatis* can synthesize glycogen in its developmental cycle, including in elementary bodies, reticulate bodies, and intermediates (especially in elementary bodies). When cells are stained with iodine for light microscopy, glycogen accumulation is an important feature to distinguish *C. trachomatis* from other chlamydial species (1). Studies by Chiappino et al. confirmed that glycogen in inclusions originated from *C. trachomatis* itself instead of host cells (1). No report on the synthesis of glycogen in host cells by other microbes has yet been found. Therefore, detection of the glycogen content in genital epithelial cells may be helpful in the diagnosis of *C. trachomatis* infections.

The amounts of serially diluted glucose were determined to evaluate the sensitivity of the glycogen assay. The results showed that this assay could determine glycogen to a concentration of as much as 1.44 μg/ml and that it had relatively high sensitivity. The plasmid primers used in PCR had been compared with results from cell culture in our previous work, and the sensitivity and specificity were 90.6 and 98.1%, respectively. These results were similar to the results (sensitivity, 100%; specificity, 93%) that Østergaard et al. (4) had obtained from evaluation of the same primers by the same method. They showed that the plasmid primers had very high sensitivity and specificity and could be regarded as a reference method for the glycogen assay.

When the critical point is set to 0.3 according to the distribution of ODs for tested glycogen contents, the sensitivity and specificity of the glycogen assay for diagnosis of *C. trachomatis* infections are 84.8 and 96.5%, respectively, compared with PCR. Of 92 samples positive for PCR, 78 were positive by the glycogen assay and 14 were false negative. This was probably owing to the very high sensitivity of PCR, which can detect elementary bodies even in a very small quantity, whereas the glycogen assay can detect glycogen only in a relatively large quantity (1). Therefore, when *C. trachomatis* is in a period of latent infection, it may give positive results by PCR and negative results by the glycogen assay. From another point of view, the results obtained by the glycogen assay can better represent symptomatic infections of *C. trachomatis*. Of 228 specimens negative by PCR, 220 were negative by the glycogen assay. The reason why some were false positive probably is that the cervical secretions of a few patients contained other types of carbohydrates.

The glycogen assay is a quick, convenient, and simple method to diagnose *C. trachomatis* infections compared with other methods. Iodine staining to detect *C. trachomatis* is adopted for cell culture instead of for detection of the organism in clinical samples. The sensitivity of Giemsa staining is very low. Its sensitivities for cervical and urethral specimens are 40 and 15%, respectively (3). The sensitivity and specificity of immunofluorescence and PCR, etc., which have been adopted in recent years, are relatively high. However, the costs of these are also high, and their application is limited by equipment. The sensitivity and specificity of the glycogen assay are relatively high, and the assay’s cost is low. If the test can be further refined, the need for photometry may be replaced by visual inspection alone.

**REFERENCES**