Cellular Immunity in Chronic Chagas' Disease

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The cellular immune response was assessed in 20 patients with chronic Chagas' disease (American trypanosomiasis). Thymus-derived lymphocyte function was determined in vivo by cutaneous reactivity to several antigens including a soluble preparation derived from Trypanosoma cruzi and sensitization to 2,4-dinitrochlorobenzene. The in vitro T-cell reactivity was investigated by the proliferative response to phytohemagglutinin and to T. cruzi antigen and by inhibition of leukocyte migration with the specific antigen. In addition, the proportion and absolute numbers of peripheral blood T- and B-lymphocytes were determined by rosette formation. This research indicates that the general and specific cellular immune response, evaluated by the tests herein mentioned, is well preserved in patients, with Chagas' disease. We conclude that chronic Chagas' disease is not associated with deficiency in cellular immunity, nor does it lead to it. Conceivably, the active participation of delayed hypersensitivity may play an important role in the expression of the human chagasic lesions.

Chagas' disease, caused by Trypanosoma cruzi, is endemic to a large area of Central and South America. Individuals with chronic infection frequently develop severe myocardopathy and, sometimes, esophageal and intestinal lesions. The nature of the acquired protective immunity in T. cruzi infections, as well as the pathogenesis of the lesions, are not clearly understood. Antibodies against T. cruzi have been demonstrated by the complement fixation test, immunofluorescence, and hemagglutination (2, 23, 25).

However, the role played by antibodies in protective immunity is controversial (6, 22). On the other hand, there is experimental evidence supporting the participation of cell-mediated immunity in the host resistance (7, 16, 18, 20). Cellular immunity has been only partially studied in patients with Chagas' disease. Cutaneous tests with T. cruzi antigen have been reported in a small number of patients (23, 26). A few in vitro investigations were done by studying the lymphocyte proliferative response to phytohemagglutinin (PHA) and specific antigen using morphological methods (23), and the inhibition of leukocyte migration (8, 25). This report presents a comprehensive assessment of cellular immunity, both in vivo and in vitro, in patients with chronic Chagas' disease.

MATERIALS AND METHODS

Twenty patients with the diagnosis of chronic Chagas' disease were studied. There were 11 males and 9 females, ranging in age from 19 to 68 years. Seventeen patients were found to have myocardial lesions, whereas only three had detectable intestinal lesions. Thirty normal subjects, from the same geographic area, matched by sex and age, were used as the control for cutaneous tests. Twenty of them served as leukocyte donors for in vitro tests.

A soluble antigen was prepared from cultures of the "Y" strain of T. cruzi (21) maintained in diphasic medium (5) and harvested after 7 days of culture. The cultures were filtered, and the parasites were washed and suspended in 0.85% NaCl at a concentration of 10⁶ cells per ml. This suspension was subjected to sonic treatment in a Biosonik apparatus, and the disintegration of the microorganisms was confirmed microscopically. After centrifugation for 20 min at 12,000 × g and 4°C, the supernatant was diluted to a concentration of 30 μg of protein per ml in 0.85% NaCl for the in vitro test and to 20 μg of protein per ml in Coca solution (1:3) for use in cutaneous tests. These concentrations were established according to other authors (8, 23) and proved to be adequate. Both preparations were sterilized by membrane filtration (Millipore Corp.), samples were separated for sterility tests, and the antigen was stored at −20°C in small samples.

Sensitization with 2,4-dinitrochlorobenzene (DNCB), as well as intracutaneous tests, were performed by methods previously described (3, 9). Skin reactions consisting of erythema and induration at 48 h, with or without vesiculation or bullae, were accepted as evidence of sensitization to DNCB. Delayed cutaneous hypersensitivity skin tests were accomplished by intradermal injection of 0.1 ml of the following antigens: purified protein derivative (PPD) (Statensseruminstitut, Copenhagen, 2 TU/0.1 ml; Candida albicans (31); Mycobacterium tuberculosis (31); Mycobacterium leprae (31); Brucella abortus (Statensseruminstitut, Copenhagen, 250 TU/0.1 ml); and Candida albicans var. tropicalis (31).

Both intracutaneous and intradermal tests were done on the forearm of patients and on the control subjects. Reactions were examined at 48 h, and the diameter of the erythema was measured with a dermatometer.

The cutaneous reactions were graded as follows: 0 = no erythema; 1 = erythema ≤ 0.5 cm; 2 = erythema > 0.5 cm and < 1 cm; 3 = erythema ≥ 1 cm. The lymphocyte response was determined by the conclusion of propagation assays performed in cultures of peripheral blood lymphocytes from patients and from normal controls. Results were expressed as the average of the incorporation of 3H-thymidine per 10⁶ cells for each experiment. As a control, 20 normal donors were studied.

In this study, the in vitro measurement of the T-cell proliferative response to phytohemagglutinin was performed on peripheral blood lymphocytes from patients and from normal controls. The incorporation of 3H-thymidine was used to measure the proliferation of lymphocytes in response to phytohemagglutinin. The results were expressed as the average of the incorporation of 3H-thymidine per 10⁶ cells for each experiment.
of the area (the dense halo around the capillary tube) was measured. The results are expressed as the “migration index,” which is the ratio: (migration area with antigen/migration area without antigen) × 100.

RESULTS

The percentage of positive delayed cutaneous reactions and the mean values of lymphocyte counts, proliferative response of lymphocytes, and leukocyte migration are summarized in Table 1.

When tested with the antigen extracted from the etiological agent, all patients presented positive delayed cutaneous reactions, ranging from 8 to 30 mm (mean, 12.3 mm). The histology of the reactions to T. cruzi antigen showed a mononuclear infiltrate with predominance of lymphocytes. Among normal subjects from the same geographic area, the percentage of positivity was 20%; reactions ranged from 5 to 8 mm, with a mean of 6.4 mm. The difference

<table>
<thead>
<tr>
<th>Determination</th>
<th>Patients</th>
<th>Controls</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cutaneous reaction (%)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>T. cruzi antigen</td>
<td>100</td>
<td>20</td>
</tr>
<tr>
<td>Purified protein derivative</td>
<td>40</td>
<td>43</td>
</tr>
<tr>
<td>Oidiomycin</td>
<td>80</td>
<td>70</td>
</tr>
<tr>
<td>PHAc</td>
<td>100</td>
<td>100</td>
</tr>
<tr>
<td>DNCB</td>
<td>90</td>
<td>90</td>
</tr>
<tr>
<td>Lymphocyte counts</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lymphocytes/mm³</td>
<td>1,764</td>
<td>1,795</td>
</tr>
<tr>
<td>T-cells/mm³</td>
<td>1,131</td>
<td>1,288</td>
</tr>
<tr>
<td>B-cells/mm³</td>
<td>370</td>
<td>382</td>
</tr>
<tr>
<td>T-cells (%)</td>
<td>63</td>
<td>62</td>
</tr>
<tr>
<td>B-cells (%)</td>
<td>21</td>
<td>24</td>
</tr>
<tr>
<td>SI²</td>
<td></td>
<td></td>
</tr>
<tr>
<td>PHA, autologous plasma</td>
<td>33.1</td>
<td>41.8</td>
</tr>
<tr>
<td>PHA, homologous plasma</td>
<td>41.4</td>
<td>45.3</td>
</tr>
<tr>
<td>T. cruzi antigen, autologous plasma</td>
<td>3.1</td>
<td>0.8</td>
</tr>
<tr>
<td>T. cruzi antigen, homologous plasma</td>
<td>4.3</td>
<td>0.8</td>
</tr>
<tr>
<td>Migration index*</td>
<td>21.7</td>
<td>88.5</td>
</tr>
</tbody>
</table>

* Statistically significant difference by chi-square test (P < 0.001).
* The SI was calculated as the ratio of thymidine uptake between stimulated and nonstimulated cultures.
* Statistically significant by Mann-Whitney test (5% level).
* MI = (mean area of migration with T. cruzi antigen/mean area of migration without T. cruzi antigen) × 100.
between the percentage of positivity to T. cruzi antigen in patients and controls was statistically significant by the \( \chi^2 \) test \((P < 0.001)\). The percentage of positivity to the intradermal test with purified protein derivative, oidiomycin, and PHAc, as well as to DNBC sensitization, was similar in patients and normal controls.

The absolute number and percentage of peripheral blood E and HEAC rosette-forming cells observed in patients with chronic Chagas' disease did not differ statistically (Mann-Whitney test) at the 5% level from those of normal controls.

The proliferative response to PHA among patients with Chagas' disease was almost normal. Our experience with a large number of PHA lymphocyte cultures from normal subjects indicated that cultures with SIs lower than 10.0 are depressed and with SIs between 10.0 and 20.0 are slightly depressed. Lymphocytes from three of the patients showed the proliferative response to PHA to be slightly diminished in autologous plasma, but not in homologous plasma.

We considered a positive proliferative response to T. cruzi antigen to be cultures with a stimulation index equal to or greater than 2.0. Fourteen (70%) of the patients showed a proliferative response to the specific antigen, of higher than 2.0 in autologous plasma, and 18 (90%) showed this in homologous plasma. This response was significantly higher at the 5% level, by the Mann-Whitney test, than that observed in normal donors. The mean of the response of the control group to T. cruzi antigen was 0.8 in autologous and homologous plasma. Only one of the normal subjects presented a positive proliferative response (SI = 1.8) in autologous plasma, but the response in homologous plasma was negative (SI = 1.1).

Migration indexes lower than 75 were considered inhibitory. Peripheral leukocytes of all the patients were inhibited in their migration in the presence of T. cruzi antigen. Leukocytes from normal donors were not inhibited. The difference between patients and controls regarding inhibition of leukocyte migration with the specific antigen was highly significant by the Mann-Whitney test.

DISCUSSION

Evaluation of the thymus-dependent immune competence in this group of patients demonstrated that cellular immunity is preserved in chronic Chagas' disease. The percentage and absolute numbers of peripheral T- and B-lymphocytes, the response to cutaneous tests with ubiquitous antigens, the ability to be sensitized by DNBC, and the proliferative response of lymphocytes to PHA did not differ significantly in patients and the control group. The patients' lymphocytes response to PHA in vitro was normal in either homologous or autologous plasma, indicating absence of humoral blocking factors. Unlike that observed in some other infectious diseases (11, 15, 24), American trypanosomiasis does not seem to contribute to depression of the general mechanisms of cellular immunity.

Only among patients with a chagasic megacolon could some degree of impairment of cellular immunity be foreseen. We studied only three of these patients, but it is interesting to note that two of them were unable to be sensitized with DNBC and showed a proliferative response slightly depressed to PHA and T. cruzi antigen in autologous plasma. Further work is needed before proposing that patients with intestinal lesions may differ from those with cardiopathy in presenting some impairment of the immune competence.

Concerning the response to T. cruzi antigen, our results confirm and extend those described by others (8, 23, 25) in demonstrating that patients with Chagas' disease are able to show delayed hypersensitivity to the etiological agent. With the soluble antigen prepared by us, we observed 100% positivity in delayed cutaneous reactivity among patients compared to 20% in normal subjects from the endemic area. In keeping with the in vivo response, peripheral leukocytes from all the patients were inhibited in their migration in the presence of the T. cruzi antigen. Although Lechuk et al. (8) found that soluble antigens are less effective than particulate antigens in promoting inhibition of leukocyte migration, we were able to find 100% positivity in this test in our patient population, whereas the control group showed no migration inhibition. Patients' lymphocytes showed a proliferative response to T. cruzi antigen in autologous and homologous plasma significantly higher than that of the controls. Tschudi et al. (23) obtained similar results using morphological methods to evaluate blastic transformation.

We did not find any evidence that some specific failure in cellular immunity to the parasite could be responsible for the chronicity of Chagas' disease. On the contrary, our results are compatible with the hypothesis that cell-mediated immunity may be operative in the pathogenesis of the lesions.

There is accumulating evidence that a steady balance between host and parasite is usually present in Chagas' disease and that
cellular immunity is important in this balance: parasitemia is very low, and it is remarkably difficult to find parasites at the sites of the lesions (4); outbreaks of high parasitemia can be obtained only by using strong immunosuppressive agents (1, 18); experimental, acute Chagas' disease is easily induced after neonatal thymectomy or treatment with antithymocyte serum (17, 20); and immunity is achieved by lymphocyte transfer (7, 16, 18). On the other hand, the presence in the heart of mononuclear cell infiltrates suggests the possible participation of immune mechanisms, especially autimmune and delayed hypersensitivity reactions, in the pathogenesis of the chagasic cardiopathy (14). In keeping with these concepts, Santos-Buch and Teixeira (19) have recently reported in vitro lysis of allogeneic, parasitized, and nonparasitized heart cells by T. cruzi-sensitized rabbit lymphocytes. The destruction of nonparasitized heart cells and the recognition of a cross-reaction between antigens of parasite and host heart myofibers have indicated that a parasite-induced, cell-mediated immune reaction directed towards the host cell is the basis of subsequent myocardial injury in experimental Chagas' disease.

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LITERATURE CITED


