Immunoglobulin Binding in Cardiomyopathic Hearts

By Sunil K. Das, M.D., Jeffery P. Callen, B.A., Vernon N. Dodson, M.D., and James T. Cassidy, M.D.

SUMMARY

Bound gamma globulin was demonstrated by the direct immunofluorescent technique in heart tissue from three patients with severe congestive cardiomyopathy. In two of these patients complement (β1C) was also bound to the heart muscle. Heart tissue from one of six patients who died of myocardial infarction showed a trace of bound gamma globulin, but no bound complement. During life, the heart in advanced cardiomyopathy may preferentially fix heart-reactive immunoglobulins to specific sarcolemmal and subsarcolemmal antigens, and antiheart antibody may not be detectable in the serum.

Additional Indexing Words: Cardiomyopathy Gamma globulin Immunofluorescence Complement

SERUM ANTIBODY directed against heart muscle (HAb) has been reported in patients with various forms of heart disease.1-3 It has been postulated that HAb is the result rather than the cause of the injury in these conditions. Despite severe cardiac disability in patients with idiopathic cardiomyopathy, HAb surprisingly is not found in increased frequency. Thus Fletcher and Wenger4 and Camp et al,5 with an indirect immunofluorescent technique, found no increase in prevalence of HAb in the sera of cardiomyopathic patients compared with that of control subjects. Similarly, we found no increase in prevalence of HAb in 35 patients with cardiomyopathy.6 An explanation for this enigma may be provided by the observations of Sanders and Ritts,7 who found bound gamma globulin in the hearts of five of nine patients with cardiomyopathy. In the present study, the hearts of three patients with the severe congestive form of cardiomyopathy, whose sera were negative for HAb, were examined for bound gamma globulin.

Methods

Heart muscle was obtained from three male patients (age range 39 to 48 years, mean 44 years) with the congestive form of cardiomyopathy who underwent cardiac transplantation. A summary of their clinical data is shown in Table 1. The diagnosis of idiopathic cardiomyopathy was confirmed in each following detailed histopathologic examinations of the hearts. Heart tissue was obtained at autopsy from seven individuals who died of noncardiac causes. This group included four adults (age range 18 to 33 years) and three infants. Heart tissue was also obtained from six older patients (age range 66 to 78 years) who died within 1 week of acute myocardial infarction. In the majority of cases in the control groups, heart tissue was obtained within 4 hours of death and in all cases within 6 hours of death.

All tissues were studied in a comparable manner. A section of heart was frozen rapidly with a mixture of dry ice and acetone and stored at -70°C. Four-micra sections were cut on a cryostat and placed on microscope slides. The
sections were dried at room temperature, fixed in acetone for 15 min, and redried for 30 min. They were washed in phosphate-buffered saline, pH 7.4 (PBS), for 10 min, and then were incubated with fluorescein-labeled rabbit antihuman gamma globulin* in a humidity chamber for 45 min. Excess antiserum was removed, and the sections were washed three times for 10 min each. They were counterstained with Eriochrome Black and mounted in Elvanol. Specificity of staining was corroborated by blocking experiments of alternate slides with nonlabeled rabbit antihuman gamma globulin applied before the labeled antiserum. Calf heart muscle was used as a substrate control. The tissue sections were examined by ultraviolet light microscopy. Monospecific antisera to the heavy chains of immunoglobulin G (IgG), immunoglobulin A (IgA), and immunoglobulin M (IgM) were used in order to ascertain the class of bound antibody. Binding of complement was determined in an identical manner with fluorescein-labeled goat antiserum to human complement (β2G).*

Sera were obtained from each patient with cardiomyopathy on two separate occasions prior to transplant operation and were analyzed for the presence of HAb by an indirect immunofluorescent test. Heart muscle from an infant who died of a noncardiac cause was used as substrate. Sera were not available for the seven control subjects or the six patients with myocardial infarctions prior to death. Therefore, sera from ten consecutive patients with fresh myocardial infarction (less than 1-week's duration) were tested for the presence of HAb and were retested in eight of these patients 3 to 4 weeks postinfarction.

**Results**

Two types of heart muscle fluorescence were encountered in this study. These were termed the *sarcolemmal* and *subsarcolemmal* types, based on the description by Kaplan and his associates.1 The former consisted of linear staining confined to sites along the periphery of the muscle fibers. The subsarcolemmal type consisted of staining confined to sites within the muscle fiber. The degree of fluorescence was graded from 0 to 4+. A 1+ reaction consisted of definite fluorescence predominantly of the sarcolemmal type seen in scattered areas. A 4+ reaction indicated intense staining predominantly of the subsarcolemmal type.

The results of the direct immunofluorescent tests from the three groups of patients are

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*Hyland Company.

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<table>
<thead>
<tr>
<th>Clinical Data in Three Patients with Cardiomyopathy</th>
<th>Cardiacomegaly</th>
<th>Cardiomegaly, pulmonary congestion</th>
<th>Marked cardiacomegaly, pulmonary congestion</th>
<th>Cardiomegaly, pulmonary congestion</th>
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</thead>
<tbody>
<tr>
<td>Physical findings</td>
<td>ECG</td>
<td>Duration of symptoms</td>
<td>Symptoms</td>
<td>Sex</td>
</tr>
<tr>
<td>P.B.</td>
<td>BP 110/70</td>
<td>5 years</td>
<td>Diaphoresis</td>
<td>M</td>
</tr>
<tr>
<td>D.K.</td>
<td>BP 110/75</td>
<td>3 years</td>
<td>Fatigue</td>
<td>M</td>
</tr>
<tr>
<td>C.B.</td>
<td>BP 110/72</td>
<td>7 years</td>
<td>Diplopia</td>
<td>M</td>
</tr>
<tr>
<td>Abbreviations: BP = blood pressure; LBBB = left bundle-branch block; LVH = left ventricular hypertrophy; PND = paroxysmal nocturnal dyspnea.</td>
<td>Cardiomegaly</td>
<td>Cardiomegaly, pulmonary congestion</td>
<td>Cardiomegaly, pulmonary congestion</td>
<td>Cardiomegaly, pulmonary congestion</td>
</tr>
</tbody>
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shown in table 2. Heart tissue from two of the three patients with severe congestive cardiomyopathy contained abundant bound gamma globulin predominantly in subsarcolemmal sites (fig. 1). The heart from the third patient showed a moderate degree of subsarcolemmal and sarcolemmal staining. The predominant type of immunoglobulin bound to heart muscle was found to be IgG. Bound gamma globulin was not present in heart tissue obtained from any of the seven patients dying of noncardiac causes (fig. 2). However, a weak sarcolemmal staining was present in one of the six patients who died of myocardial infarction; this woman had suffered two previous myocardial infarctions. Complement was bound in moderate degree particularly in sarcolemmal sites in the hearts of the first two patients with cardiomyopathy, but was not observed in any of the other hearts in this study.

Sera obtained prior to transplant operations from the three patients with cardiomyopathy were negative for HAb by the indirect immunofluorescent test. Sera obtained within a week of the episode from the 10 patients with myocardial infarction and from eight of

<table>
<thead>
<tr>
<th>Diagnosis</th>
<th>Number of patients</th>
<th>Average age (years)</th>
<th>Negative</th>
<th>Positive</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cardiomyopathy</td>
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<td>44</td>
<td></td>
<td>3</td>
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<tr>
<td>Myocardial infarction</td>
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<td>69</td>
<td>5</td>
<td>1*</td>
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<tr>
<td>No heart disease</td>
<td>7</td>
<td>14</td>
<td>7</td>
<td>0</td>
</tr>
</tbody>
</table>

*This patient had two previous myocardial infarctions.

Figure 1

Heart tissue from a patient with severe congestive cardiomyopathy showing bound gamma globulin in dense white streaks located predominantly in subsarcolemmal sites (A) and to a lesser extent in sarcolemmal sites (B).
these 10 patients 3 to 4 weeks later showed no HAb.

Discussion

Circulating antiheart antibody has not been reported to occur with increased frequency in patients with cardiomyopathy, although van der Geld et al. reported HAb in 23 of 43 patients with endomyocardial fibrosis, a disorder peculiar to Africa and other tropical countries. In our study, six of 35 patients with cardiomyopathy had HAb. Moreover, none of the nine patients in class IV functional state (New York Heart Association) had HAb by the direct immunofluorescent technique. One of the patients with HAb deteriorated symptomatically and 8 months later showed no evidence of HAb preterminally. It is possible that HAb may occur early in cardiomyopathy and disappear as the disease advances. It is also possible that not all patients with cardiomyopathy produce HAb. The heart may adsorb HAb in advanced disease and remove it from circulation. A somewhat analogous mechanism is thought to be operative in certain types of human glomerulonephritis in which gamma globulin is bound to the kidney while circulating antikidney antibody is absent. Finally, HAb may circulate periodically as an immune complex with antigen and thus remain undetected by the usual serologic methods.

Heart tissue from the control patients did not show bound gamma globulin except in one case (table 2). Although these tissues were obtained within 6 hours of death, while the operative cases were obtained fresh, there was no evidence of autolysis in the routine histologic sections of any of the tissues. It is unlikely that the differences in timing could have played any important part in the observed changes. The mechanism by which gamma globulin is bound within the heart muscle fiber is not clear. Cellular permeability appears to be an essential prerequisite as antibodies theoretically cannot enter living cells. Injury, such as rheumatic fever, could
alter cell membrane permeability and enable gamma globulin to localize within the muscle fiber. Similarly, repeated myocardial infarctions might account for the gamma globulin binding that was observed in one patient in our study. Although there are no data that indicate that bound gamma globulin in the heart plays a causal role in the pathogenesis of cardiomyopathy, it is possible that it may interfere with cardiac function.

Complement was observed in the heart tissue of two of the three patients with cardiomyopathy in sites which corresponded to areas of bound gamma globulin localization. This finding is supportive evidence that autoimmune mechanisms might be operative. Serum complement was not assayed prior to transplant operations. However, other parameters of immunologic reactivity, such as precipitating antibodies to nuclear constituents, antinuclear antibodies, rheumatoid factors, and positive serologic tests for syphilis, were not present. An increase in the serum IgM concentration greater than the mean +2 standard deviations was observed in two of the three patients.

Sanders and Ritts observed bound gamma globulin in the hearts of a majority of their patients; however, the prevalence of HAb prior to the immunopathologic study was not reported. Based on their findings, they speculated that an autoimmune mechanism might have pathogenic significance in cardiomyopathy. In their study the age of the patient at the time of examination did not appear to influence the likelihood of finding bound gamma globulin. Other investigators in studies of serologic factors in cardiomyopathy concluded that autoimmune mechanisms were not responsible for the disease in the majority of patients. The bound gamma globulin observed in cardiomyopathic hearts might be unrelated to autoimmunity, but rather might be related to some other pathologic process, possibly infection. Serial immunopathologic and serologic studies will be necessary to determine if immune mechanisms are indeed involved. An autoimmune etiology would be enhanced if eluted gamma globulin from these hearts produced cardiomyopathy in suitable animals.

Acknowledgments

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References

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SUNIL K. DAS, JEFFERY P. CALLEN, VERNON N. DODSON and JAMES T. CASSIDY

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