Serum Transaminase Levels in Experimental Myocardial Infarction

By Clarence M. Agress, M.D., Howard I. Jacobs, M.S., Harvey F. Glassner, A.B., Marianne A. Lederer, Wm. G. Clark, Ph.D., Felix Wroblewski, M.D., Arthur Karmen, M.D., and John S. LaDue, M.D., Ph.D.

Serum glutamic oxalacetic transaminase concentrations rise sharply after myocardial infarction produced by bead embolization of the coronary tree in the closed chest dog. The peak concentration is reached in 9 to 23 hours post injury. Rises 20 to 30 times greater than normal may be obtained and are directly correlated with the amount of infarction estimated at autopsy. Serial serum transaminase levels may provide a clinical tool to supplement the electrocardiogram in the diagnosis of acute myocardial infarction as well as provide a roughly quantitative estimate of the amount of myocardium involved.

Clinical and laboratory studies performed on human subjects have shown that the serum level of glutamic oxalacetic transaminase rises significantly following acute myocardial infarction. However, in order to determine the relationship, if any, between serum transaminase levels and amount of infarcted muscle in clinical cases, careful pathological studies will have to be made on autopsy material over a span of many years. Therefore, it was decided to attempt to determine the nature of this relationship in experimental animals.

By utilizing the method of Agress and his associates, graded experimental infarction was produced in dogs. Then, a quantitative estimation of infarcted muscle at autopsy could be correlated with any changes in serum transaminase level.

Methods

Fourteen dogs weighing an average of 20 Kg. (range 19 to 29 Kg.) were used. Intravenous Nembutal was chosen as the anesthetic. Two dogs were used as sham operated controls. The remaining 12 dogs were subjected to coronary embolization with plastic microspheres. By this method, a steel catheter is passed through the left carotid artery into the ascending aorta of the closed chest dog, and plastic microspheres are injected into the coronary ostia after occlusion of the aorta by inflation of a special balloon.

Control serum samples were taken on all dogs before and one hour after the introduction into the aorta of the catheter used in the embolization technique. Spheres were then injected into the coronary arteries until S-T depressions in the electrocardiogram appeared. Previous studies have shown that when persistent S-T segments shifts occur following coronary embolization with plastic microspheres, infarction has been produced. This point was taken as the time of injury. The dogs were kept under light anesthesia and serum samples were withdrawn one hour post injury and every four hours thereafter, for the first 24 to 36 hours on nine dogs. Three dogs were observed for as long as 72 hours. These sera were shell-frozen and lyophilized. The lyophilized sera were coded and sent from the Los Angeles laboratory to the New York laboratory for serum transaminase analysis. The serum transaminase levels were determined by the method of LaDue, Wroblewski and Karmen.

At autopsy, black-and-white and color photographs were taken of the hearts before and after serial sections were made at approximately 1 cm. intervals through the left ventricle and septum (fig. 1). The amount of infarction was estimated in terms of per cent of total myocardium after gross study of the epicardial and endocardial surfaces and of the serial sections. These estimations are believed to be reliable to within 5 to 10 per cent, based on our experience with several hundred hearts of this type. It is to be noted that these estimations of the amount...
Fig. 1. Left ventricle and septum. Note discrete areas of infarction throughout myocardium—from endocardial to epicardial surfaces.

![Image of myocardium with discrete areas of infarction]

Fig. 2. A table illustrating the relationship between per cent of myocardial infarction, as estimated at autopsy, and peak serum transaminase level.

<table>
<thead>
<tr>
<th>% INFARCTION</th>
<th>INITIAL T-A LEVEL</th>
<th>PEAK T-A LEVEL</th>
<th>PEAKTIME POST INJ.</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>60</td>
<td>40</td>
<td>0</td>
</tr>
<tr>
<td>10 - 20%</td>
<td>5</td>
<td>19</td>
<td>128</td>
</tr>
<tr>
<td>10 - 20%</td>
<td>22</td>
<td>296</td>
<td>15 hrs.</td>
</tr>
<tr>
<td>20 - 30%</td>
<td>22</td>
<td>296</td>
<td>15 hrs.</td>
</tr>
<tr>
<td>30 - 40%</td>
<td>15</td>
<td>450</td>
<td>15 hrs.</td>
</tr>
<tr>
<td>50% +</td>
<td>16</td>
<td>728</td>
<td>20 hrs.</td>
</tr>
</tbody>
</table>

The rise in transaminase in experimental myocardial infarction, thus confirms that seen clinically and, in addition, the data show a semiquantitative relationship between the serum level and the amount of injected myocardial tissue. The mechanisms of the physical and temporal nature of the serum rise are not known, but it has been shown

some instances, the rises were as great as 20 to 30 times that of the control levels. Moreover, these data suggest that there is a rough correlation between the amount of infarction estimated at autopsy and the peak transaminase level.

When the amount of infarction is plotted against the peak transaminase level, a similar correlation between the two variables (fig. 3) is apparent.

The time course of serum transaminase levels is shown in figure 4. A marked rise in serum transaminase level occurs following experimental myocardial infarction in all cases. The peak transaminase level occurs between 9 to 23 hours post injury, with a decline after this point. In many of the experiments, a gradual progressive increase in transaminase level occurred after the clearly defined primary peak. The explanation for this is not yet known, but as this phenomenon also occurred in a control dog, we believe it unlikely that it can be a function of myocardial infarction. Rather, it is possibly due to the prolonged anesthesia. However, this remains to be determined by further experimentation.
that the transaminase level of infarcted myocardial tissue is markedly decreased from normal.

CONCLUSIONS

The results of this cross-country collaborative study in which the data were independently determined, lead to the conclusions that (1) in all cases the serum transaminase levels rose sharply after myocardial infarction, (2) there exists a relatively linear correlation between the peak serum transaminase levels and the amount of myocardial infarction as estimated at autopsy, and (3) infarction of as little as 10 per cent, and possibly less, of the total myocardium is associated with significant rises in transaminase levels.

The method of serum transaminase analysis, as developed by Karmen, Wroblewski and LaDue, is simple and quick and can be performed in most clinical laboratories. It is believed that serum transaminase determinations will prove useful as a clinical tool to supplement the electrocardiogram in the diagnosis of acute myocardial infarction, and will probably provide a roughly quantitative estimate of the amount of myocardium involved. The preliminary results are promising and deserve further study.

CONCLUSIONES IN INTERLINGUA

Le resultatos de iste studio cooperative—con datos determinate independentemente per participantes in California e New York—impone le sequente conclusiones: (1) Post infarcimento myocardiac le nivello del transaminase seral exhibi un acute augmento. (2) Il existe un correlation plus o minus linear inter le nivello maximal de transaminase seral e le grado de infarcimento myocardiac apparente al autopsia. (3) Infarcimento de solo 10 pro cento (o possibilemente mesmo de minus que 10 pro cento) del myocardio total es associate con un significative augmento del nivello de transaminase.

Le analyse del transaminase seral secundo le metodo desenvoloppate per Karmen, Wroblewski, e LaDue es simple e rapide e pote esser executate in le majoritate del laboratorios clinic. Nos opina que determinationes de transaminase seral se provara utile como supplemento clinic de methodos electrocardiographic in le diagnose de acute infarcimento myocardiac. Illos va probablemente provar se capace a fornir plus o minus satisfacente estimationes quantitative del portion de myocardio involvite. Le resultatos preliminari es promittente e merita studios additional.

REFERENCES

Serum Transaminase Levels in Experimental Myocardial Infarction
CLARENCE M. AGRESS, HOWARD I. JACOBS, HARVEY F. GLASSNER, MARIANNE A. LEDERER, WM. G. CLARK, FELIX WROBLEWSKI, ARTHUR KARMEN and JOHN S. LADUE

Circulation. 1955;11:711-713
doi: 10.1161/01.CIR.11.5.711

Circulation is published by the American Heart Association, 7272 Greenville Avenue, Dallas, TX 75231
Copyright © 1955 American Heart Association, Inc. All rights reserved.
Print ISSN: 0009-7322. Online ISSN: 1524-4539

The online version of this article, along with updated information and services, is located on the World Wide Web at:
http://circ.ahajournals.org/content/11/5/711

Permissions: Requests for permissions to reproduce figures, tables, or portions of articles originally published in Circulation can be obtained via RightsLink, a service of the Copyright Clearance Center, not the Editorial Office. Once the online version of the published article for which permission is being requested is located, click Request Permissions in the middle column of the Web page under Services. Further information about this process is available in the Permissions and Rights Question and Answer document.

Reprints: Information about reprints can be found online at:
http://www.lww.com/reprints

Subscriptions: Information about subscribing to Circulation is online at:
http://circ.ahajournals.org/subscriptions/