TRICHINELLA SKIN TESTS IN AN ORPHANAGE AND PRISON.
COMPARISON WITH SEROLOGIC TESTS FOR TRICHINOSIS
AND WITH THE TUBERCULIN REACTION

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The possibility that an unrelated disease process may alter the reaction to the trichinella skin test was uncovered in the course of an investigation on the incidence of trichinosis. A higher percentage of positive skin reactions to trichinella antigen (18.3 per cent) was obtained in 674 patients with active tuberculosis confined in 3 sanatoria, than was found in 335 patients without tuberculosis (7.2 per cent) studied in 2 general hospitals for shorter periods of time (1). On the other hand, the incidence (18.4 per cent) in 825 patients without active tuberculosis confined in 3 hospitals for mental diseases was almost identical with that found in the sanatoria. This finding suggested that some factor connected with residence in an institution might account for the high incidence. An analysis of positive reactors according to the duration of stay in an institution revealed that the incidence of positive reactions reached a peak at 18 to 29 months; no history suggesting subclinical institutional epidemics was elicited (1).

Experiments were undertaken to determine whether positive trichinella skin tests could be produced in the absence of infection by the ingestion of killed trichinae, as in meat rendered non-infectious by cooking inadequate to denature the protein of the parasite. Sensitization was not induced in the animals used for these experiments (2). The possibility of a biologic cross reaction, detectable by skin test, between Mycobacterium tuberculosis and Trichinella spiralis was investigated in rabbits infected with trichinae and a bovine strain of tubercle bacilli simultaneously. No cross reaction was detected in these rabbits by skin tests (3).

The present experiments were undertaken to determine whether a biologic cross reaction de-

1 This study was aided by a grant from the John and Mary R. Markle Foundation.
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in a separate building with a separate kitchen; hence, this group in effect represents 2 institutions. No prisoner had roentgenologic evidence of pulmonary tuberculosis when a photo-roentgen survey was made a few months prior to the initiation of this study. Pork raised on the prison farm is served once weekly. The quantity of pork eaten at the prison appears to have been slightly greater for the 2 years preceding the test than that eaten at the orphanage.

METHODS

In all instances, a 1:10,000 solution of trichinella extract (Lederle) and a phenolized phosphate buffer saline control solution were used. A 1:1,000 dilution of tuberculin (Lilly) in distilled water and the tuberculin control solution were freshly prepared for use in each institution.

New syringes and needles were obtained for the skin tests, and were not used for any other purpose. One syringe and needle was always used for each test solution, and 2 others for the controls; the syringes and needles were never interchanged. After being used, they were washed with distilled water only, placed in marked tubes, and sterilized in an autoclave.

An area on the flexor surface of both forearms was cleaned with 70 per cent alcohol, and 4 workers simultaneously injected 0.02 ml of the trichinella test and control solutions in the right arm, and 0.1 ml of the tuberculin test and control solutions in the left arm. The test solution was always injected proximal to the control solution.

The reactions were read at 30 minutes and 24 hours after injection. The tuberculin reactions were graded by the usual scale from 1 to 4 plus. The trichinella reactions were also recorded on a scale of 1 to 4 plus, 1 plus denoting an immediate reaction which exceeded the diameter of the injected bleb by 5 mm. or more (1).

Ten weeks after the skin tests were performed, blood serum was drawn from the antecubital vein of the orphans for serologic testing. Serum was obtained from the prisoners 17 to 19 weeks after skin-testing.

Flocculation tests were performed according to the technique described by Suessenguth and Kline (4). The trichinæ from which the antigen was prepared were recovered from rabbits fed 8 weeks previously on a rat infected with a strain of trichinæ parasites obtained from the National Institute of Health (2). Precipitin reactions were done with a 1:200 dilution of antigen prepared from the same dried trichinæ used for the flocculation test.

RESULTS

Skin tests

Orphanage. Fifty-seven children (20.0 per cent) gave positive trichinella skin tests; 51 were immediate reactions, and 9 were delayed reactions which appeared at 24 hours. Three tests were positive at both 30 minutes and 24 hours (Table I). Seven children reacted to both the test and control solution, and were calculated as negative in the statistical analysis. Forty children (14.0 per cent) gave positive tuberculin reactions at 24 hours. The immediate reactions to the tuberculin test and control solution were not thought to be significant. Six children reacted positively to both trichinella extract and tuberculin, and negatively to both controls. One hundred and ninety-five children gave negative reactions to all antigens at both times.

Prison. Sixty-five prisoners (27.8 per cent) gave positive reactions to trichinella antigen at some time (Table I). Fifty-two were immediate

<table>
<thead>
<tr>
<th>Institution</th>
<th>Number tested</th>
<th>Trichinella</th>
<th>Tuberculin</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>30 minutes</td>
<td>24 hours</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Positive</td>
<td>Negative</td>
</tr>
<tr>
<td>Orphanage</td>
<td>285</td>
<td>51</td>
<td>7</td>
</tr>
<tr>
<td>(male)</td>
<td>183</td>
<td>43</td>
<td>12</td>
</tr>
<tr>
<td>Prison (female)</td>
<td>58</td>
<td>9</td>
<td>1</td>
</tr>
<tr>
<td>Total</td>
<td>526</td>
<td>103</td>
<td>20</td>
</tr>
</tbody>
</table>

* Three patients had positive reactions at both 30 min. and 24 hrs.
Since the interpretation of immediate and delayed reactions to trichinella antigen is still in doubt, positive reactions at either period were compared with late tuberculin reactions (Table III). No correlation between positive reactions to tuberculin and trichinella antigen was found. The data were tabulated according to duration of stay in each institution (Table I). The duration of stay in an institution did not appear to affect the incidence of late reactions; however, the incidence was found to be highest in the orphanage (Table II). The comparison of late tuberculin reactions at either period were compared to the control solutions. One prisoner reacted to both tuberculin and trichinella antigen, and did not react to the control solution. Two prisoners reacted to both tuberculin and the control solution at 24 hours. One hundred and sixty-three prisoners reacted negatively to all antigens at both times.

### Table II

<table>
<thead>
<tr>
<th>Institution</th>
<th>Tuberculin (4 hrs)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Prison (male)</td>
<td>0 1+ 2+ 3+ 4+</td>
</tr>
<tr>
<td>0+</td>
<td>2 9 14 6 7</td>
</tr>
<tr>
<td>1+</td>
<td>0 1 0 0 0</td>
</tr>
<tr>
<td>2+</td>
<td>0 0 0 0 0</td>
</tr>
<tr>
<td>3+</td>
<td>0 0 0 0 0</td>
</tr>
<tr>
<td>4+</td>
<td>0 0 0 0 0</td>
</tr>
</tbody>
</table>

### Table III

**Comparison of extent of reaction to trichinella skin tests with duration of stay in an institution**

<table>
<thead>
<tr>
<th>Years</th>
<th>Orphanage</th>
<th>Prison (males)</th>
<th>Prison (females)</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Number</td>
<td>Number</td>
<td>Number</td>
<td>Tested</td>
</tr>
<tr>
<td></td>
<td>Positive</td>
<td>Positive</td>
<td>Positive</td>
<td>Positive</td>
</tr>
<tr>
<td></td>
<td>Per cent</td>
<td>Per cent</td>
<td>Per cent</td>
<td>Per cent</td>
</tr>
<tr>
<td>0</td>
<td>0 1+ 2+ 3+ 4+</td>
<td>0 1+ 2+ 3+ 4+</td>
<td>0 1+ 2+ 3+ 4+</td>
<td>0 1+ 2+ 3+ 4+</td>
</tr>
<tr>
<td>1</td>
<td>11 6 1 0 0</td>
<td>10 1 1 0 0</td>
<td>9 1 0 0 0</td>
<td>20 2 0 0 0</td>
</tr>
<tr>
<td>2</td>
<td>6 1 1 0 0</td>
<td>5 1 1 0 0</td>
<td>4 0 0 0 0</td>
<td>15 2 0 0 0</td>
</tr>
<tr>
<td>3</td>
<td>6 1 1 0 0</td>
<td>5 1 1 0 0</td>
<td>4 0 0 0 0</td>
<td>15 2 0 0 0</td>
</tr>
<tr>
<td>4</td>
<td>6 1 1 0 0</td>
<td>5 1 1 0 0</td>
<td>4 0 0 0 0</td>
<td>15 2 0 0 0</td>
</tr>
<tr>
<td>5</td>
<td>6 1 1 0 0</td>
<td>5 1 1 0 0</td>
<td>4 0 0 0 0</td>
<td>15 2 0 0 0</td>
</tr>
<tr>
<td>6</td>
<td>6 1 1 0 0</td>
<td>5 1 1 0 0</td>
<td>4 0 0 0 0</td>
<td>15 2 0 0 0</td>
</tr>
<tr>
<td>7</td>
<td>6 1 1 0 0</td>
<td>5 1 1 0 0</td>
<td>4 0 0 0 0</td>
<td>15 2 0 0 0</td>
</tr>
<tr>
<td>8</td>
<td>6 1 1 0 0</td>
<td>5 1 1 0 0</td>
<td>4 0 0 0 0</td>
<td>15 2 0 0 0</td>
</tr>
<tr>
<td>9</td>
<td>6 1 1 0 0</td>
<td>5 1 1 0 0</td>
<td>4 0 0 0 0</td>
<td>15 2 0 0 0</td>
</tr>
<tr>
<td>10</td>
<td>6 1 1 0 0</td>
<td>5 1 1 0 0</td>
<td>4 0 0 0 0</td>
<td>15 2 0 0 0</td>
</tr>
<tr>
<td>11 to 15</td>
<td>0 0 0 0 0</td>
<td>0 0 0 0 0</td>
<td>0 0 0 0 0</td>
<td>0 0 0 0 0</td>
</tr>
<tr>
<td>16 to 20</td>
<td>0 0 0 0 0</td>
<td>0 0 0 0 0</td>
<td>0 0 0 0 0</td>
<td>0 0 0 0 0</td>
</tr>
<tr>
<td>Total</td>
<td>228 27 15 12 6</td>
<td>288 60** 20.8</td>
<td>130 23 19 11 3</td>
<td>186 56** 30.0</td>
</tr>
</tbody>
</table>

* Three orphans had both immediate and delayed positive tests.  
** Three prisoners had both immediate and delayed positive tests.
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**TABLE IV**

*Comparison of serologic reactions for trichinosis with skin tests*

<table>
<thead>
<tr>
<th>Institution</th>
<th>Positive trichinella skin test</th>
<th>Positive tuberculin skin test</th>
<th>Negative trichinella and tuberculin skin test (control)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Flocculation</td>
<td>Precipitin</td>
<td>Flocculation</td>
</tr>
<tr>
<td></td>
<td>Tested</td>
<td>Positive</td>
<td>Negative</td>
</tr>
<tr>
<td>Orphanage</td>
<td>57</td>
<td>38</td>
<td>0</td>
</tr>
<tr>
<td>Prison</td>
<td>53</td>
<td>44</td>
<td>(±)</td>
</tr>
<tr>
<td>(male)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Prison</td>
<td>12</td>
<td>9</td>
<td>(±)</td>
</tr>
<tr>
<td>(female)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>122</td>
<td>91</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td>2(-)*</td>
<td>14</td>
<td>0</td>
</tr>
</tbody>
</table>

* Sera with doubtful (±) flocculation gave negative precipitin test.
** Sera with 3+ flocculation gave negative precipitin test.

**Serologic reactions**

*Orphanage.* Flocculation tests for trichinosis were performed on serum from 38 children with positive trichinella skin tests, from 20 children with positive tuberculin and negative trichinella skin tests, and from 20 who reacted negatively to all antigens. All flocculation tests were negative (Table IV). No precipitin tests were done on the children.

*Prison.* Flocculation tests were performed on serum from 53 prisoners with positive reactions to trichinella antigen, from 5 with positive delayed tuberculin reactions, and from 51 who reacted negatively to all antigens (Table IV). Five sera from the group with positive trichinella skin tests, and 2 from the group negative to both antigens, gave doubtful flocculation reactions; 2 of the latter group gave strongly positive flocculation reactions. Precipitin tests were performed on serum from 20 prisoners with positive trichinella reactions, from 5 with positive tuberculin reactions, and from 18 who were negative to all antigens; none were positive. Serum had been collected from the other prisoners after a meal and was too cloudy for performance of accurate precipitin tests. Precipitin tests on serum from rabbits known to be infected with trichiniae were strongly positive; these tests served as a control on the technique and the potency of the antigen.

**DISCUSSION**

No correlation has been found between the tuberculin and trichinella skin reactions; this clinical observation agrees with the results of experimental investigations in rabbits (3). No biologic cross reaction detectable by skin test appears to exist; the increased incidence of positive trichinella skin tests in tuberculous patients is still unexplained.

Whether the apparent increase in the incidence of positive trichinella skin tests among patients confined to any institution is connected with subclinical institutional epidemics, cannot be categorically stated. The fact that the flocculating antibodies and precipitins appear to bear no relation to positive skin reactions would argue against subclinical institutional epidemics. However, precipitins are known to persist for 2½ years after proven infection in human beings (5). The length of time for which flocculating antibodies persist in human beings is not known, but in swine the test remains positive for 10 months (4). It is possible that different antigens are involved in the production of the skin test and the serum reactions (6).

The increase in the incidence of positive skin reactions previously noted after 2 years' residence in an institution was confirmed at the orphanage; at the prison the peak was later, but in general the relation of positive skin tests to length of institutionalization followed the data previously reported (1). The explanation for this relationship is still obscure.

The wide variation in the incidence of positive reactions obtained in the 9 institutions which have now been studied cannot yet be explained.

While a positive tuberculin skin reaction does
not indicate the presence of active tuberculosis, it
does indicate that the individual has been infected
at some time and is allergic to some fraction of
the organism. It would be reasonable to expect
some degree of correlation between the skin re-
tactions to tuberculin and trichinella antigen if
one disease affects the severity of the other, as was
suggested by the experiments in guinea pigs pre-
viously reported (7). Perhaps active tuberculosis
is necessary for the infection with trichinae to be
enhanced; the present study cannot answer this
question.

That tuberculosis may affect the course of trichi-
nosis was shown also by studies of the eosinophil
response of guinea pigs (8). The injection of live
virulent \textit{M. tuberculosis} depressed the number of
circulating eosinophils in trichinous animals. Since
a rapid rise in eosinophils is the most frequent and
easily detected early laboratory evidence of uncom-
plicated trichinosis, the absence of eosinophilia in
a tuberculous patient with a positive trichinella
skin test could cause confusion in diagnosis.

It is known that the electrical resistance of the
skin of disturbed mental patients may vary mark-
edly from that of the same patient after recovery
(9). Previous studies with trichinella antigen in
one mental hospital suggested that the reactivity
to biologic products may be altered in the same
way (1). Though none of the prisoners or or-
phans gave a history of active mental disease, it
is true that all prisoners have committed an off-
fense and may justly be suspected of having a
psychiatric disturbance. Many orphans may like-
wise have some mild psychiatric manifestations.
None of the individuals studied was acutely dis-
turbed, however, and hence would not be ex-
pected to have an altered skin reaction.

**SUMMARY**

1. No correlation between the trichinella skin
test and the tuberculin reaction was found in 526
individuals confined in an orphanage or a prison.
The incidence of positive trichinella skin tests in
241 prisoners was 27.8 per cent; the incidence in
285 orphans was 20.0 per cent.

2. Positive serologic reactions to the floccula-
tion or precipitin tests were not found in persons
with positive trichinella skin reactions.

3. The duration of stay in an institution is ap-
parently a factor in determining the incidence of
positive trichinella skin tests. The explanation for
this finding is obscure.

**BIBLIOGRAPHY**

1. Harrell, G. T., and Horne, S. F., Trichinella skin
tests in tuberculosis sanatoriums, hospitals for
mental diseases, and general hospitals. A com-
parison of results in tuberculous and non-tubercu-

2. Avera, John W., Yow, E. M., Harrell, G. T., and
Fowler, E. B., An attempt by feeding to induce in
animals reactivity to \textit{Trichinella spiralis} in the ab-

3. Harrell, G. T., and Helsabeck, N. J., The effect on the
trichinella skin test of simultaneous infection with
bovine tuberculosis in trichinous rabbits. J. Clin.
Invest., 1947, 26, 69.

4. Suessenguth, H., and Kline, B. S., A simple rapid
flocculation slide test for trichinosis in man and in

5. Gould, S. E., Trichinosis. Charles C. Thomas, Spring-
field, Illinois, 1945, p. 143.

6. Aikawa, J. K., Harrell, G. T., and Helsabeck, N. J.,
The effect of peptic and tryptic digestion on the
antigenicity of \textit{Trichinella spiralis}. J. Clin. Invest.,
1947, 26, 73.

7. Davis, O. T., Harrell, G. T., and King, E. S., The ef-
effect of simultaneous tuberculous infection on ex-
perimental trichinella infestations in guinea pigs.

8. Spink, W. W., Effects of vaccines and bacterial and
parasitic infections on eosinophilia in trichinous

9. Barnell, A., Correlations between epidermal impedance
and the clinical course in certain psychoses. Proc.