A STUDY OF THE RELATIONSHIP OF THE SCROTAL SWELLING AND RICKETTSIA BODIES TO MEXICAN TYPHUS FEVER

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In the study of typhus fever at the present time, etiological investigation turns to a considerable extent upon whether or not the small rickettsia-like bodies described in the scrotal swellings by Mooser can be looked upon as the causative agents, or whether they represent merely a secondary infection carried along through generations of guinea pigs together with the typhus virus.

Some light may be thrown upon this question by the occasional strains of Mexican typhus fever in which scrotal swelling does not occur for several guinea pig generations and then, for unknown reasons, reappears. Such strains have been noted from time to time by ourselves as well as others, and the purpose of the present paper is to describe the results of guinea pig inoculations in which a number of strains taken directly from patients were carried on in series of considerable length with irregularity in the appearance of swelling. The experiments described deal with a strain isolated at Jilotzingo which is spoken of briefly as the "J" strain.

Appearance of Scrotal Swelling in Guinea Pigs Directly Inoculated from Patients

Table I shows that inoculations from three patients in the same epidemic, the blood of each injected into three guinea pigs, resulted in positive reactions in all three of the guinea pigs from Patient 1; in none of those inoculated from Patient 2 and in only one guinea pig inoculated from Patient 3. In only one animal of the four successful inoculations—successful as far as fever reaction is concerned—did scrotal swelling appear, but it is important to note that the typical

swelling in this case was produced directly as the result of inoculation with human blood.

The Frequency of Scrotal Swelling in Guinea Pigs Inoculated in Series with the "J" Strain

The observations recorded in Table II are important in that there was only an occasional scrotal reaction in the guinea pigs inoculated up to the sixth generation. Then, for eight generations, from the seventh to the fifteenth, the scrotal reaction was absent. After that it recurred in two guinea pigs of the sixteenth generation. It was

TABLE I

Patient	Guinea pig	Results
1	1	Fever, no swelling
	2	Fever, swelling
	3	Fever, no swelling
2	4	No fever or swelling
	5	No fever or swelling
	6	No fever or swelling
3	7	No fever or swelling
	8*	Fever
	9	No fever or swelling

* Guinea pig 8 was a female, the others being males.

In this experiment guinea pigs were carefully selected to avoid contamination with Salmonella, which frequently occurs in Mexico City.

lost again from the seventeenth to the twentieth generation, and again from the twenty-second to the twenty-third, but reappeared in the twenty-fourth generation.

Rickettsia were not found in any of the animals showing swelling until the twenty-fourth generation. This we are inclined to attribute to the fact that we had not yet learned that the rickettsia are difficult to find unless the examination is made quite early. At the height of the swelling—4 to 6 days after inoculation—the rickettsia are much more difficult to find than when the tunica is examined at the very first indication of reaction, or even before reaction has become manifest.

At any rate, the experiments recorded in the table show that after prolonged failure of scrotal swelling, the typical Neill-Mosser reaction with rickettsia can appear, a point that would suggest strongly that the rickettsia and the lesion in the tunica vaginalis are truly part of the typhus fever and not incidentally carried along.

Cross Immunity Experiments

We considered it of some importance also to determine whether a typhus fever without scrotal swelling in guinea pigs immunized to subsequent inoculation with a Mooser strain which produced swelling

TABLE II

No. of passage	Material injected	No. of guinea pigs with typhus fever	No. of guinea pigs with swelling	Rickettsia	No. of guinea pigs with no swelling
1st	Human blood	4	1	0	3
2nd	Guinea pig blood	5	0		5
3rd	Guinea pig blood	5	1	0	4
4th	Guinea pig blood	6	2	0	4
5th	Guinea pig blood	4	1	0	3
6th	Guinea pig blood	4	1 (slight)	0	3
7th to 15th	Guinea pig blood	24	0		24
16th	Guinea pig blood	3	2	0	1
17th to 20th	Guinea pig blood	10	0		10
21st	Guinea pig blood	2	1	0	1
22nd to 23rd	Guinea pig blood	4	0		4
24th	Guinea pig blood	2	1 (early castrated)	++++	1
25th	Guinea pig blood	2	0		2

with considerable regularity. Of thirty-three guinea pigs inoculated with the "J" strain in this series, only four showed scrotal swelling. Nine were unsuccessfully inoculated, showing neither fever nor swelling. Twenty, which showed typical fever curves but no swelling of the scrotum, were subsequently reinoculated with the typical Mooser strain and in no case developed either swelling or fever.

The nine unsuccessfully inoculated pigs were all reinoculated similarly and all of them developed both fever and swelling.

From these experiments it is clear that a typhus fever conveyed

by the "J" strain and recovered from without scrotal lesion protects against the scrotal lesion upon subsequent inoculation with the typical Mooser strain.

This would again indicate that the scrotal lesion is merely an incidental localization in some guinea pigs of the disease which is immunized against by a general typhus fever, even if in the course of the latter this lesion is absent.

TABLE III

Guinea pig	Passage No.	Fever	Swelling	Rickettsia
a	2nd	+	−	
b	3rd	+	+	0
c	4th to 15th	+	−	
d	16th	+	+	0
e	17th to 20th	+	−	
f	21st	+	+ slight	0
g	22nd to 24th	+	−	
h	25th	+	+	Very few extracellular

From Guinea pig "h" (25th passage) lice were then intrarectally inoculated with tunica by the Weigl method and after 10 days this material was injected into guinea pigs with the following results:

Guinea pig	Lice strain. Passage No.	Fever	Swelling	Rickettsia
i	1st	+	+	++++
j	2nd	+	+	++++
k	3rd to 5th	+	−	
l	6th	+	+	++++

The Influence upon the Ability of a Strain to Cause Scrotal Swelling after Passage through Lice

Table III again shows the "J" strain, carried in twenty-five generations with frequent absence of scrotal swelling for a number of generations, even after the twenty-fifth generation is passed through lice and reinoculated into guinea pigs. In the first two generations after passage through lice, typical swelling with abundance of rickettsia

occurred, then again for two generations swelling and rickettsia were absent, in spite of typical febrile reactions, to reappear in the sixth generation as markedly as they had been present before.

SUMMARY

The experiments recorded above have demonstrated the following points:

1. Scrotal swelling can appear in guinea pigs directly inoculated from a human case of Mexican typhus fever.

2. In certain strains of this disease, a number of generations of guinea pigs may show absolutely no scrotal swelling, which, however, may reappear in subsequent animals, suggesting—though not absolutely proving—that the scrotal swelling is an integral part of the disease and is not due to an incidental accompanying organism. If the latter were true, one would expect the organisms that caused the scrotal swelling to disappear during the negative generations.

3. A typhus fever sustained by a guinea pig without scrotal swelling protects against the swelling upon subsequent inoculation with a strain which produces this with considerable regularity.

4. Louse passage increases the capacity of a strain to produce the scrotal lesion, probably because of the considerable accumulation of rickettsia in the louse, but in the experiment noted, even after louse passage, two generations without swelling occurred, followed by reoccurrence of the swelling.

We believe that these observations, taken together, can be interpreted in favour of the likelihood that the swelling is a part of the disease and that the rickettsia-like organisms described by Mooser in the tunica vaginalis have etiological significance.