SOME ASPECTS OF THE PRESENCE OF SURFACE – A ASSOCIATED ACID MUCOSUSTANCES ON LARVAL TAENIA SAGINATA INFEKTING SUITABLE AND UNSUITABLE HOSTS

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Abstract. The coat of acid mucosubstances occurring on the bladder surface was studied in Cysticercus bovis (larvae of Taenia saginata) developing in specific (cattle) and nonspecific (some other ruminants) intermediate hosts. In cysticerci developing in nonspecific intermediate hosts, this coat is absent or poorly developed even at the time when it is completely formed on the bladder surface of C. bovis from cattle. If the cysticercus develops up to the infective stage in a nonspecific intermediate host, it is usually localized outside the muscles: in the brain, lungs or liver. Its bladder is then also covered by a coat of acid mucosubstances. The absence or insufficient development of the protoscolicidal coat on larvae in nonspecific intermediate hosts is explained by their early and strong tissue reaction.

While studying the development of Cysticercus bovis after experimental peroral infection of calves with Taenia saginata eggs it was found that the bladder tegument of C. bovis was covered by a complex of acid mucosubstances from the 4th week. It was demonstrated that the acid mucosubstances were not produced by the parasite, but that they got to its surface from the zone of tissue reaction surrounding the larva at the beginning of infection (Schramlová and Blažek 1984). These glycoproteins corresponded to the electron-dense substance detectable in the contact zone between the parasite and the host tissue while studying the ultrastructure. The coat of acid mucosubstances appeared on the bladder surface in the 4th week after infection and covered even the surface of a morphologically fully differentiated cysticercus (Blažek and Schramlová 1986, Schramlová and Blažek 1981). It is assumed that this complex of substances bound to the bladder surface enables the cysticercus at the stage of hypobiosis to survive for a long time inside the immune host organism.

To obtain more information about the significance of superficial mucosubstances it was observed whether they occur also on the surface of cysticerci developing in the subcutis of cattle after inoculation with T. saginata oncospheres or in nonspecific hosts of T. saginata which are known to produce a rapid immune reaction to C. bovis. In these hosts C. bovis usually dies soon after infection and develops up to the infective stage only exceptionally or in an atypical localization (Bocuž et al. 1984, Geerts et al. 1981, Blažek and Schramlová 1983, Kirichek 1985, Blažek et al. 1986). Results of these observations are described in the present paper.

MATERIALS AND METHODS

Excisions from muscles with C. bovis cysticerci from kids and lambs experimentally infected with T. saginata eggs, cysticerci from naturally infected kids and from kids immunologically suppressed by immunization, histological sections with cysticerci in muscles and brain meninges of rendering, cysticerci

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RESULTS

A coat of acid mucousubstances covering the bladder surface of cysticerici localized in muscles of cattle, a specific intermediate host of T. saginata, starts to appear in the 4th week after infection. Five weeks p.i. it is completely developed on the whole bladder surface. At that time, the reaction for acid mucousubstances is strongly positive on the microtriches of both bladder and scolex, but also between disintegrating macrophages in immediate vicinity of larva in granulation tissue. Six to seven weeks after infection, this reaction is strongly positive on the bladder surface, but weak in the tissues in the subabs, the reaction for acid mucousubstances on the bladder surface is week or negative in the 4th week p.i. Also in the surrounding tissues the reaction for acid mucousubstances is very weak. Six to seven weeks p.i., the reaction is here AB-positive, but markedly weaker than in cysticerici localized in muscles (Table 1).

Table 1. Detection of acid mucousubstances in the cysticerici and the host tissue

<table>
<thead>
<tr>
<th>Animal</th>
<th>4—5 weeks p.i.</th>
<th>6—7 weeks p.i.</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>Bladder tegument</td>
<td>Zone of macrophages</td>
</tr>
<tr>
<td>Calf muscles</td>
<td>++</td>
<td>++</td>
</tr>
<tr>
<td>Calf subunits</td>
<td>++</td>
<td>++</td>
</tr>
<tr>
<td>Lamb muscles</td>
<td>++</td>
<td>++</td>
</tr>
<tr>
<td>Lamb lungs</td>
<td>++</td>
<td>++</td>
</tr>
<tr>
<td>Kid muscles</td>
<td>++</td>
<td>++</td>
</tr>
<tr>
<td>Neonatal kid</td>
<td>++</td>
<td>++</td>
</tr>
<tr>
<td>Immuno-suppressed kids</td>
<td>++</td>
<td>++</td>
</tr>
<tr>
<td>Reindeer brain</td>
<td>++</td>
<td>++</td>
</tr>
</tbody>
</table>

+ slight positivity, ++ medium positivity, +++ marked positivity, ++++ strong positivity, ± very slight positivity, 0 not formed

Completely morpologically differentiated cysticerici from liver of spontaneously infected cattle, around which almost no reaction was observed, were found to be strongly AB-positive on the bladder surface (on microtriches and in the uppermost layer of distal cytoplasma). In the larvae the reaction for acid mucousubstances was marked only on the periphery of granulation tissue surrounding the larva 4—5 week p.i. On the surface of larvae, which had the shape of a bladder without scolex, the AB reaction was only weakly positive. In the period of 6—7 weeks p.i., the cysticerici were mostly dead and sometimes even disintegrated. In the larvae with preserved morphological structure the scolex was not yet formed and there was only a very weak reaction for acid mucousubstances on the bladder microtriches and in the surrounding tissues. If there exceptionally occurred a cysticerici which was still well developed and possessing a scolex (e.g., in lungs), the coat of acid mucousubstances was present and the reaction for their detection was of medium positivity.

In 2-month-old kids, which were perorally infected with T. saginata eggs, the reaction for acid mucousubstances on the surface of larva was somewhat stronger than in lambs 4—5 weeks p.i. Like in the lambs, the development of larva was retarded and the scolex anlage was not developed. The reaction for acid mucousubstances was also weak in the granulation tissue around the larvae.

The cysticerici from a kid which was infected during the neonatal period (on 4th day after birth) were large, but they had the shape of a bladder without scolex 5 weeks p.i. The structure of the bladder wall was indistinct and the wall was mostly destroyed by eosinophiles. There were only neutral mucousubstances on the surface of these larvae or AB reaction was of medium positivity but diffused in the whole height of the bladder wall. The coat of acid mucousubstances, which would outline the surface of the larva, was not formed.

The kids injected intravenously with Imuran before and at the beginning of infection harboured cysticerici with scolex 2 months p.i. and the AB reaction demonstrated the presence of acid mucousubstances on the surface of the larva localized in the specific tissue. At three of the larvae in the bladder wall was thickened. AB positivity of medium intensity was evenly distributed in their whole height, as it was observed in the neonatally infected kid.

The larvae localized in muscles of the reindeer died soon after infection. On day 74 p.i., when a retarded cysticerici was found in the node, only neutral mucousubstances could be detected on the tegument and an uneven layer of AB-positive substances occurred on the bladder surface in the zone of microtriches. A marked positive reaction for the presence of acid mucousubstances was demonstrated on the microtriches of completely developed cysticerici localized in the brain meninges.

DISCUSSION

Histochemical tests for the detection of acid mucousubstances showed that the surface of T. saginata larvae developing in nonspecific hosts contained neutral mucousubstances even at the time when a large amount of acid mucousubstances occurred on the bladder surface of larvae localized in the specific tissue. During the abortive development of C. bovis in nonspecific intermediate hosts a small amount of acid mucousubstances could be detected in the granulation tissue already in the second week p.i. and a greater amount in the fourth and fifth weeks p.i. However, the AB positivity on the bladder surface was very low, while in the larvae localized in muscles of cattle it was high at that time (Sobramlová and Blažek 1984).

The coat of acid mucousubstances on the surface of larvae from sheep and reindeer was formed only in case that the larvae developed in an atypical localization, e.g. in lungs (in sheep) or in brain meninges (in reindeer). The AB reaction was of medium to great intensity. The AB positivity on the bladder surface was somewhat stronger in kids than in lambs in the same period of infection. In the kids, whose immune system was not yet perfectly developed at the time of infection or was artificially suppressed (neonatal infection, Imuran treatment), the cysticerici developed better, but they died as soon as the immune system completely developed or when the effect...
of the immunosuppressor disappeared. In these cases the AB positivity was strong in the bladder wall but evenly distributed in the whole height of the wall which is supposed to be the manifestation of dystrophic changes and beginning destruction of the bladder by the host cells.

In the subcutis of cattle, the coat of acid mucosubstances on the cysticercus surface was formed more slowly and the AB reaction was weaker than in the cysticerci localized in muscles. It is worth mentioning that there was also a marked coat of acid mucosubstances on the surface of the cysticercus which developed up to the infective stage in the goat subcutis (Schramlová and Blažek, unpublished observations). The coat of acid mucosubstances on the bladder surface of fully developed cysticerci from cattle liver was well formed.

Acid mucosubstances on the surface of cestode larvae and in their vicinity have been studied also by other authors. Letonja and Hamnerber (1983) demonstrated acid mucosubstances on the surface of Taenia taeniaformis larvae at the age of 30 days. Later they studied the development of T. taeniaformis larvae in the liver of susceptible and resistant hosts and found that the amount of acid mucosubstances around the larvae was the same in both suitable and unsuitable intermediate hosts on day 2 p.i. (Letonja et al. 1984). However, the positivity of the reaction for acid mucosubstances decreased in the resistant hosts during the following days. On day 10 p.i., the acid mucosubstances were no more detected and the majority of larvae were destroyed by the host's cellular reaction at that time. In the susceptible hosts, the larvae further developed, the positivity of reaction for acid mucosubstances on their surface increased, and acid mucosubstances were detected even in the host tissues around the larva.

Acid mucosubstances on the surface of T. taeniaformis larvae developing in susceptible hosts were found also by Bartoletti and Ferretti (1985). In a further paper they demonstrated that the coat of acid mucosubstances was not formed or only very weakly if the larvae were localized in resistant or relatively resistant intermediate hosts (Bartoletti et al. 1985). The observations of T. taeniaformis as a model showed that if the larva developed successfully, its surface was covered with a coat of acid mucosubstances after some time. This corresponds with our results obtained in our studies of C. botii infection in cattle and non-specific hosts. In addition we have observed the presence of acid mucosubstances in larvae of some other cestodes. They were found on the surface of fully developed coenurus of T. multiceps (11 weeks p. i.) localized in the brain and in morphologically differentiated larvae of T. taeniaformis localized in the liver. It was not formed in young coenurus (18 days p. i.), in young living or dead strobilocerci of T. taeniaformis (in mouse liver), and in cysticerci of T. pisiformis (in rabbits) and T. hydatigena (in pigs) which migrated through the liver. However, the coat of acid mucosubstances was demonstrated on the surface of those T. pisiformis and T. hydatigena larvae which were situated on the surface of the liver or immediately below it. We have found that a coat of acid mucosubstances appeared on the surface of C. botii and T. hydatigena cysticerci approximately at the time when their metabolic activity started to decrease, i.e. at the time when the activity of alkaline and acid phosphatases decreased.

It is demonstrated (Schramlová and Blažek 1984) that the acid mucosubstances occurring on the bladder surface of C. botii from the 4th week p. i. are mostly of the host origin, though some authors assume that they are secreted by the parasite (Heath and Smyth 1970). The acid mucosubstances can be demonstrated sooner in the tissue surrounding C. botii than on its surface. Histological, histochemical, and electron-microscopic studies showed that these substances flow from the inflammation zone towards the larva, be it from the cells of the proliferate, serum, or blood plasma, filling the tissue around the larva at the early phase of infection. A polysaccharide component and proteins partly with SS and SI groups, but particularly proteins with SS groups of cystine type were demonstrated in the tissue complex on the bladder surface (Schramlová and Blažek 1984).

In relation with the significance of acid mucosubstances or glycoproteins occurring on the surface of T. saginata from specific and non-specific intermediate hosts, interesting results were obtained by some authors regarding the immunological properties of egg antigens in T. saginata: a) cysticerci obtained from long-term donors (Siebert et al. 1981), demonstration of host serum proteins on the surface of T. solium cysticerci (Willis and Arons 1977), and analysis of proteins associated with the surface of Taenia sp. cysticerci showing that the main surface antigens are glycoproteins (Parkhouse and Harrison 1987). These findings and results of the present paper support our earlier hypothesis that the mucosubstances in a complex with proteins associated with the surface of C. botii and some other larval cestodes mask the cysticerci so that it is not identified by the host as a "foreign" agent (Schramlová and Blažek 1984, 1988). The host proteins adsorbed on the tegument surface of larvae can make impossible the attachment of the respective antibody (Willis and Arons 1977) and the cysticerci are thus protected from the immune host organism for a long time. The complex of surface-associated substances, however, may comprise factors interacting with the complement and the destructive effect of the complement may be thus blocked. It was shown, using T. taeniaformis larva as model (Hamnerberg and Willis 1978), that the active substance in the complex of surface-associated substances is probably polysulfated proteoglycan, the molecules of which occur on the surface of various infectious organisms known to react with the complement.

The hitherto obtained results show that several mechanisms may be involved in the parasite survival in an immune host. However, it remains unclear why the complex of substances on the surface of larvae from non-specific intermediate hosts is formed insufficiently or exceptionally. It may be only generally concluded that this complex is formed if the non-specific intermediate host turns from a high responder (in the immunological sense) to a low one or in organs with a certain degree of immunological tolerance. Only under these conditions C. botii can successfully develop even in a non-specific host.

**NEКОТОРЫЕ АСПЕКТЫ ПРИСУТСТВИЯ КИСЛЫХ МУКОСУБСТАНЦИЙ НА ПОВЕРХНОСТИ ЛИЧИНКИ TAENIA SAGINATA, ПАРАЗИТИРУЮЩИХ У СПЕЦИФИЧЕСКИХ И НЕСПЕЦИФИЧЕСКИХ ХОЗЯЕВ**

Я. Шрамлова, К. Блажек и Я. Прокович

**Резюме.** Извучили оболочку кишечных мукосубстанций, встречающихся на поверхности личинки цистицерка Taenia saginata (также известной как цистицерка цистицерка), развивающейся в специфическом (в низкокислотом рогатом скоте) и неспецифическом (в низкокислотых животных) хозяев. У цистерна, паразитирующих у неспецифического рогатого скота, эти оболочки отсутствуют или недостаточно развиты, в то время как они развиваются на поверхности цистерна цистерна цистерна от круглого рогатого скота. Это подчеркивает различие в иммунных реакциях в специфическом и неспецифическом хозяине, то есть в виде, лишенные или имеющиеся, в противном случае, цистерна, может быть, и патогенными."
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