Attempts to transmit hepatitis B virus to chimpanzees by arthropods

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Summary

Bedbugs (Cimex lectularius L.) were fed on an infective blood-hepatitis B virus (HBV) mixture. Further bedbugs and tampan ticks (Ornithodoros moubata Murray) were fed on HBV-carrier chimpanzees. After a 10 - 13 day interval for oviposition, tests done on samples of individual arthropods showed that neither bedbugs nor ticks were HBV-positive. The remaining arthropods were fed on 3 susceptible chimpanzees. Subsequently the presence of viable virus in the original infective meals was confirmed by inoculation of the relevant donor sera directly into the 3 still susceptible chimpanzees. HBV infections quickly followed in each animal. It is concluded that, while mechanical transmission of HBV is unlikely after a 10 - 13 day interval between feedings in bedbugs and ticks, it is still possible that mechanical transmission between humans might occur during interrupted feedings.

Materials and methods

Three transmission experiments were conducted using 3 HBV-positive chimpanzees as carriers. Blood was drawn from a human donor 2 hours before the bugs were fed, while the serum was obtained 3 days earlier from the blood of a carrier-donor. Until used, the serum was kept at -20°C except for a sample which was kept for 11 months to confirm that HBV was still present as an infective agent.

Tests done on this sample for HBsAg, HBcAg, and anti-HBc were positive except anti-HBc and anti-HB. The donor chimpanzees were bled and a liver biopsy taken just before they were exposed to arthropods. HBsAg, HBcAg, and anti-HBc were determined in all liver samples and none of them was HBV-negative.

Methods

Infective donor blood. In experiment 1, the infective meal consisted of a mixture ofSubmit

infectd blood and serum in the proportion 2:1. The blood was drawn from an HBV-negative human donor, anti-HBs and anti-HBc donor less than 2 hours before the bugs were fed, while the serum was obtained 3 days earlier from the blood of a carrier-donor. Until used, the serum was kept at -20°C except for a sample which was kept for 11 months to confirm that HBV was still present as an infective agent.

Results

The bedbug feeding rates on chimpanzees were consistently high at both the first and second feeds (81 - 97%) after 4 - 5 years. The feeding rates were very high for both HBsAg and HBcAg in the ticks, while HBsAg positivity varied from 53% to 85% in bedbugs and no HBsAg was detected. No arthropods in samples of 6 - 10 individuals that had not taken infective meals were found positive in any of the experiments.

Discussion

The direct inoculation of sera corresponding to those of the original infective blood meals into the still susceptible recipient chimpanzees clearly produced HBV infection in all of these animals. Thus it was confirmed that the blood meals were infectious and contained viable HBV. It must therefore be concluded that adult C. lectularius and adult O. moubata will readily transmit HBV mechanically by bite if an interval elapses between the infecting and transmission feeds sufficient to permit digestion of blood, egg development and oviposition. Such an interval would be expected in the normal course of events before bedbugs or ticks would refed.
With bedbugs, however, it is still possible that mechanical transmission between humans could occur by interrupted feeding. Unfortunately, a shortage of chimpanzees prevented the inclusion of an experiment to test this in the present study. In such instances there would be an interval lasting only a few minutes between the start of feeding on an HBV carrier and the completion of the blood meal on a susceptible person. Although there is some evidence that interrupted feeding may occur in *C. lectularius* in the laboratory,\(^{16}\) whether it occurs in natural human bedbug infestations is not known. One previous experiment was reported in which the mechanical transmission of HBV was attempted by interrupted feeding of mosquitoes on chimpanzees.\(^ {17}\) Two attempts to transmit virus by 100 *Aedes aegypti* from a carrier to 2 different susceptible chimpanzees failed. It would seem unlikely that bedbugs would succeed where mosquitoes failed unless bedbugs differ from mosquitoes in the anticoagulatory enzymes introduced at the time of biting. Perhaps enzymes secreted onto the mouthparts of *C. lectularius* would not inactivate the virus present, whereas this would occur in mosquitoes as suggested by Berquist et al.\(^ {17}\) In the case of *O. moubata*, it is unlikely that interrupted feeding would occur because once a tick has attached itself to its host it is not easily dislodged.

The two other possible routes for mechanical transmission previously suggested for bedbugs and tick transmission cannot be ruled out on the basis of the results of the present experiments.\(^ {17}\) These are, firstly, the infection of a susceptible person by means of bedbug faeces or by tick coxal or rectal fluid, which could occur by scratching of skin lesions or mucosal surfaces that had been contaminated by these products. Secondly, a person may become infected because he crushes the bug or tick and then scratches the area of the bite or mucosal surfaces causing self-inoculation with infectious material. However, these routes now appear less likely. Serological studies to determine the prevalence of HBV among blacks with viral hepatitis admitted to Johannesburg hospitals,\(^ {18}\) and among residents of Kangwane (South Africa) and Ovamboland (Namibia),\(^ {19}\) showed a rise in the HBsAg and HBeAg positivity between the age of 2 years and 4 years accompanied by a fall in anti-HBs positivity. This paucity of perinatal positivity between the age of 2 years and 4 years accompanied by a fall in anti-HBs positivity points to the horizontal spread of HBV among young children and other modes of transmission must be considered. These might include contamination from open sores caused by impetigo or by scratches and cuts incurred during rough play.

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