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POLYCYSTIC LIVER IN FOUR WHITE-TAILED DEER[1]

J. PICONE,[2] J.F. WILLIAMS, R. WESLEY LEID and L.D. FAY

Abstract: Over a 12-month period, four white-tailed deer *(Odocoileus virginianus)* were encountered in Michigan which had multiple cysts of the liver. No cystic lesions were present in other organs of the carcasses of three of the animals available for study. Light and electron microscopic observations on the lesions showed that they resembled a polycystic deformity of the biliary system, similar to that described previously in man. Polycystic liver must be differentiated from hepatic echinococcosis, which it resembles closely in gross appearance.

INTRODUCTION

Cystic lesions of the liver in animals are uncommon, and information concerning their origin and development is scanty. Nonparasitic cysts are recognized occasionally in aged dogs[9] and in ruminants,[5] though whether they are comparable in structure to the solitary cystic[8] and polycystic[2,4] changes of the liver that have been recorded in man is unclear. Recently, we encountered a polycystic condition in white-tailed deer *(Odocoileus virginianus)* in Michigan and report here on the gross and microscopic appearance of the lesions in four animals.

CASE HISTORIES AND GROSS PATHOLOGIC FINDINGS

In September, 1977, necropsies were performed on 26 adult female deer which had been under observation for the previous year at the Michigan Department of Natural Resources deer pens at the Houghton Lake Wildlife Research Station, Michigan. All of these animals were born of does confined in individual pens at the facility, and they were raised with their dams until weaned at 5 months of age.

At necropsy, two of the does were noted to have multiple cysts scattered throughout the livers. There were no other gross cystic lesions in the carcass of either doe, and clinical abnormalities had not been noted in either animal during the course of the observation period. Several encapsulated cysts containing *Fascioloides magna* were present in each liver. One of the livers was infected with cysticerci resembling *Taenia hydatigena*, although the scolex hooks were slightly smaller than those described in the literature for this species. Five other animals in the group were infected with cysticerci, and livers of the majority of the deer contained *F. magna*.

The fluid-filled cysts in each of the affected livers were variable in size (Fig. 1) ranging from a few mm to several cm in diameter. Most were clustered in polycystic masses, but isolated single cysts, containing up to 30 ml of clear fluid also were present, protruding from the

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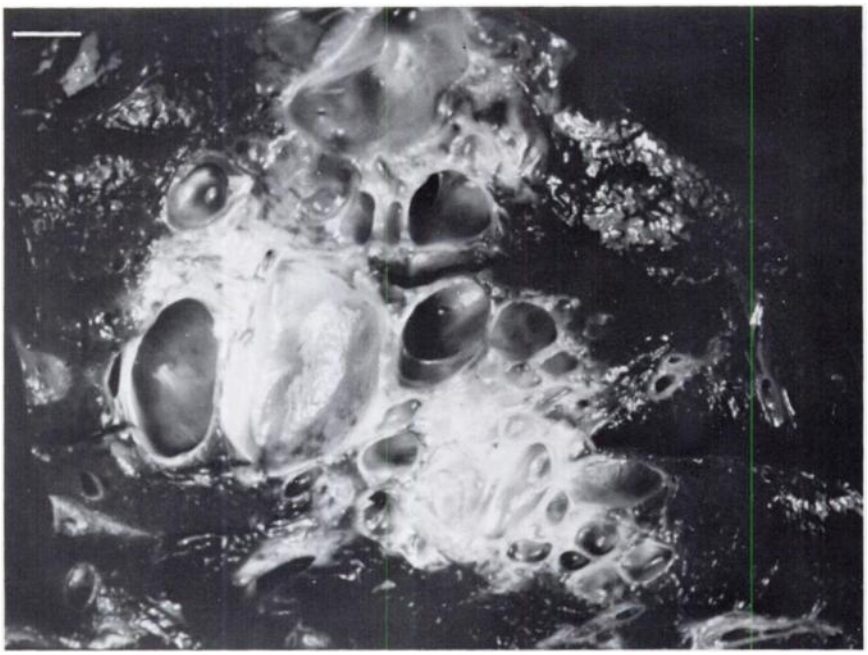


FIGURE 1. Polycystic mass within parenchyma of liver of white-tailed deer. Individual cysts were not loculated. Smaller cysts were filled with clear jelly-like fluid. Bar equals 1 cm.

hepatic surface. At the hepatic margins, there were numerous tiny solitary cysts barely visible to the naked eye. The consistency of the contents of the lesions varied from clear, thin and watery in larger cysts, to a jelly-like mucus in the denser masses within the parenchyma. The average protein concentration of fresh, pooled samples collected by needle puncture from each liver was 3.3 mg/ml.

Two further cases of cystic liver were encountered, one in the spring and the other in the fall of 1978. The first case was found in a mature doe that had been killed on the road near Lansing. There were no remarkable lesions in the carcass unattributable to trauma, except for the presence of multiple hepatic cystic masses, similar in appearance to those described previously. The liver also contained several encapsulated *F. magna*. The second case was a hunter-killed mature doe so the entire carcass was unavailable, but the liver was submitted to the Department of Natural Resources for study. The hunter reported that the deer was fat and showed no signs of having been in poor health. The liver was enlarged to over twice the normal size, and even in those areas in which lesions were not visible from the surface, cystic masses were present throughout the parenchyma (Fig. 2).

MICROSCOPIC EXAMINATION

Tissue samples were fixed either in 10% buffered formalin for light microscopic studies, or in a buffered glutaraldehyde-S-collidine mixture for electron microscopy. Samples for ultrastructural examination were washed in S-collidine,

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treated with osmium tetroxide, and embedded in Epon 812.[11] Ultrathin sections were stained with uranyl acetate and lead citrate,[6] and examined in a Zeiss EM 95-2 electron microscope.

RESULTS

The histopathologic and ultrastructural appearance of the cysts was similar in all four livers. Each cyst was lined by a smooth epithelium of cuboidal cells, although these were almost columnar at some points. At times, the internal surface was irregular, and outgrowths, or papillae, of flattened cuboidal cells projected into the lumen (Fig. 3a). There was no other cellular component in the contents of the cysts. Underlying the cuboidal epithelium was a layer of mature connective tissue, which had become a confluent, dense fibrous mass around the polycystic regions, but formed a discrete, firm, supportive capsule around the unilocular solitary cysts. Shapes of cysts were highly irregular in the polycystic region, but individual cysts did not appear to be loculated. There were no inflammatory cells in any of the lesions. Some hepatic cells adjacent to the cysts were flattened but, otherwise, parenchymal cells were normal in appearance, even though the extensive fibrotic reactions had disrupted the usual structural relationships in the liver.

Epithelial cells lining the cysts had a brush border of stubby cytoplasmic projections (Fig. 3b). The nuclei were central to basal in location with prominent peripheral dense chromatin clumps. Some nuclei appeared to be lobed. Nucleoli were infrequent and mitotic figures were rare. The cytoplasm of many

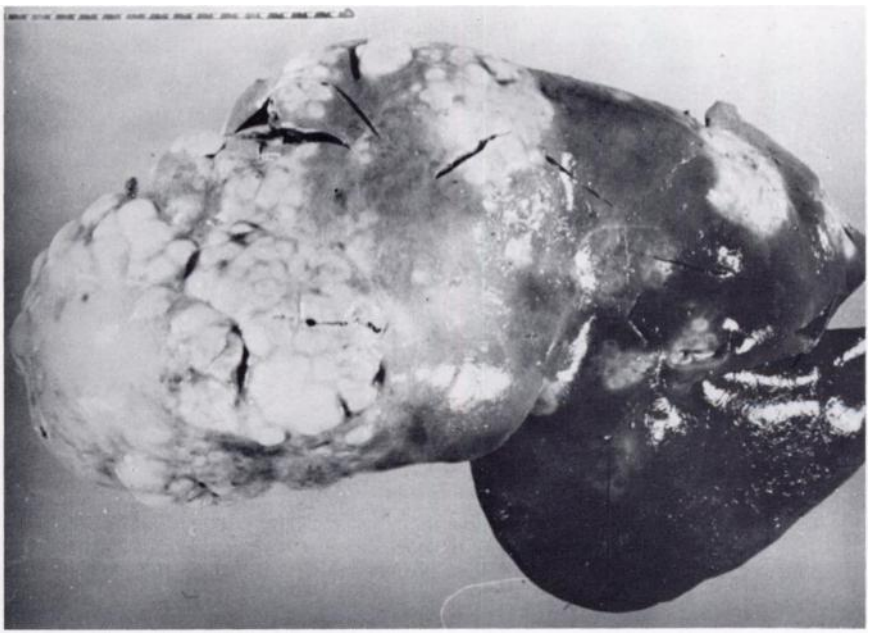


FIGURE 2. Liver from hunter-killed white-tailed deer. Almost the entire liver is disrupted by the polycystic masses which had increased the size of the organ to over twice the normal. (Scale in cm)

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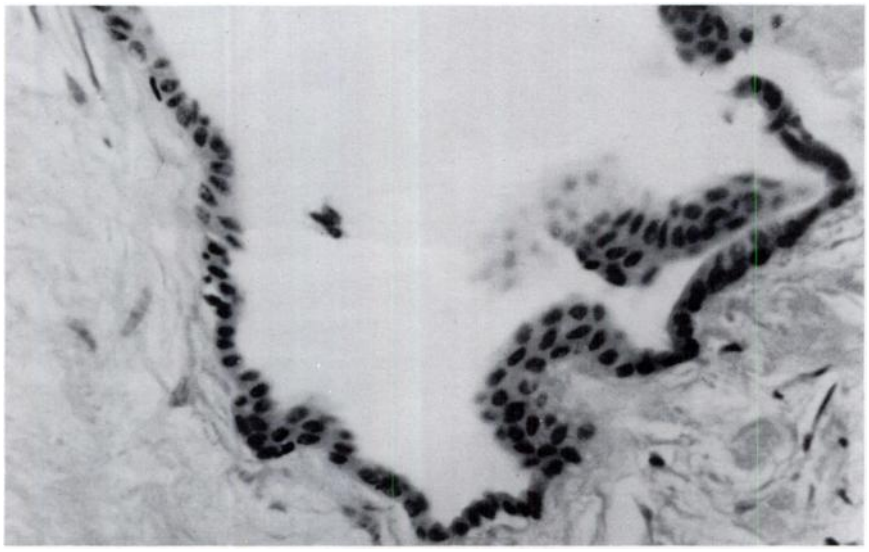


FIGURE 3a. Section showing histologic appearance of epithelial lining of hepatic cysts from white-tailed deer. Cuboidal cells occasionally form papillary outgrowths into the lumen. H&E (× 450)

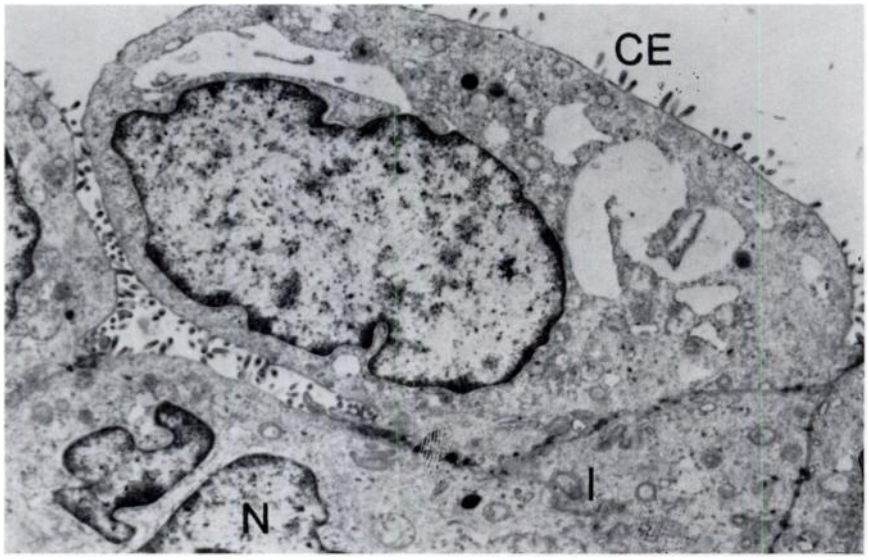


FIGURE 3b. Electron micrograph illustrating lining cells of hepatic cyst in white-tailed deer. The cells have stubby cytoplasmic extensions on the luminal border (CE). Nuclei in some cells appear lobed (N) and adjacent cells showed marked interdigitation (I). Uranil acetate and lead citrate (× 880).

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cells was heavily vacuolated, and contained mitochondria and some denser granular inclusions. Adjacent cells showed marked interdigitations.

DISCUSSION

Although antemortem examination was not done in each of these cases, it does not seem likely that the hepatic changes that we have described caused any overt signs of ill-health. Comparable lesions do not appear to have been described previously in white-tailed deer, nor is there any record in other species of clinical abnormalities attributable to hepatic dysfunction caused by multiple cystic masses.

The most common cystic structures encountered in ruminant animals are those caused by taeniid cestodes, and those which result from the encapsulation of *F. magna*. In the instances we have described, infections with *T. hydatigena*-like cysticerci and with *F. magna* were probably incidental and unrelated to the occurrence of cysts. The unilocular and multicystic masses seen commonly in the livers of cattle infected with *Echinococcus granulosus* in endemic regions[3] are remarkably similar in gross appearance to those seen in the four deer we studied. Hepatic hydatid cysts in cattle are often sterile, containing only clear, watery fluid, with no evidence of protoscolex formation. However, the microscopic and ultrastructural characteristics of the cysts in these deer showed no evidence of formation of either the germinal or laminated membranes typical of *E. granulosus*. Hydatid cysts do occur in white-tailed deer in western states of the U.S.A., but they are found predominantly in the lungs.[1,7] There are no records of cysts of either *E. granulosus* or *E. multilocularis* in any hosts in mainland Michigan, although echinococcosis has been known to occur for many years in moose on Isle Royale.[10]

The presence of a smooth cuboidal to columnar epithelial lining in these cysts, combined with the ultrastructural similarity of these cells to those of the gall bladder and biliary system of other mammals, suggest that the condition results from a cystic aberration of the biliary system. Study of a larger series of cases, however, would be needed to confirm this. Solitary and multiple cystic deformations of the liver have been described in man,[2,4,8] and in some cases, were diagnosed antemortem as a result of abdominal enlargement.[4] There is no uniformly-accepted causal factor, but the cysts are believed to arise from the proliferation of bile duct epithelial cells derived from "nests" of undifferentiated cells, separate from the biliary tree. These may represent remnants of embryonal intrahepatic bile ducts which fail to involute during development, and gradually undergo cystic dilation with age.[4] The disorder is not detectable in early life, and it is readily distinguished from the congenital cystic abnormalities sometimes present in multiple tissues of children at birth.[4] Congenital polycystic lesions have been described in a deformed fetal white-tailed deer,[12] but these were cavernous, blood-filled masses, quite unlike those in the livers of adult deer in our study.

Although we cannot suggest any particular predisposing factor for this condition in deer, its occurrence in 2 of 26 experimentally-raised animals and in two cases encountered casually in the ensuing year suggests that it is not rare. In fact, it is surprising that there do not appear to have been previous records of polycystic liver of deer in Michigan or elsewhere. In early cases, in which the deformity might consist of many small, barely-visible cysts, close examination may be necessary for detection. However, it is unlikely that the more advanced form would be overlooked. The condition should be taken into account in studies of hydatid cysts in deer populations, because the gross lesions may be confused with those caused by *E. granulosus*.

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