Inflammatory Disease of the Temporal Bone of the Brush Tail Rat (*Octodontomys Gliroides*): A Radiologic-Clinical-Pathologic Correlation

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INTRODUCTION

It is well known that rodents are especially susceptible to diseases of the inner ear. This condition is suspected clinically when head tilt, weight loss, and/or staggering gait develop. Physical examination may be difficult due to the length and small diameter of the external auditory canal; moreover, the ear canal is frequently filled with cerumen. We have recently had the opportunity to radiograph the temporal bone of brush tail rats (*Octodontomys gliroides*) affected with vestibular signs, and to compare these radiographs with those of the temporal bone of clinically normal animals. The histopathologic appearance of the affected bones was compared to the temporal bones in the normal brush tail rat.

MATERIALS AND METHODS

The National Zoological Park in Washington, D. C. maintains a colony of brush tail rats which are primarily used in behavioral studies. During one year we examined clinically and radiologically six animals affected with staggering gait, head tilt, and weight loss. Pathologic examination was done on four animals who died despite antibiotic therapy. In addition, four normal brush tail rats were radiographed and euthanized for study of the ear anatomy.

Heads presented for examination were either frozen or fixed in buffered 10% formalin. In some instances the brain was removed before decalcification; in others they were left *in situ*. Following decalcification[2] for 24–36 hours the base of the skull including the bony portion of the ear was sectioned in the horizontal plane corresponding to the radiographs. Four sections of each ear, 3–4 mm in thickness, were taken and examined grossly. The blocks were embedded with paraffin, sectioned at 6 μ, and stained with Mayer's hematoxylin and eosin.

Radiography was performed using a condenser discharge mobile radiographic unit with a 2 mm focal spot. Twenty-five percent geometric magnification was used routinely because the small structures otherwise were difficult to evaluate. In addition polytomography[3] of the temporal bones was performed at The Johns Hopkins Hospital using a 1.5 mm focal spot.

RESULTS

The anatomy of the brush tail rat ear (Fig. 1A) corresponds well with the anatomy of the guinea pig ear (2, 3). The middle ear has three cavities: the bulla; the anterior recess; the posterior recess. The anterior recess apparently corresponds to the human tympanic recess where the head of the malleus and body of the incus are situated. The posterior recess lies above the anterior recess and probably corresponds to the human mastoid antrum. The bulla is divided into 8–10 large pneumatized air cells that do not correspond to human mastoid air cells. The brush tail rat bulla is larger than the guinea pig bulla. The cochlea protrudes into the bulla medially. In the normal brush tail rat the structures mentioned above have fairly uniform radiolucency without evidence of thickening of the septae of the bulla or areas of bony sclerosis.

Polytomograms of the normal rat show the bulla to be well aerated. The more dense cochlea is medial to the bulla (Fig. 1B). Histologic sections of the healthy temporal bones show sharp definition of the bulla with no accumulation of inflammatory debris or bony reaction.

Bilateral ear infection can be detected radiologically by the dramatic increase in radiodensity of the bulla (Fig. 2A). The normal septa of the bulla are blurred, and the clear, sharp definition of the septa is not seen. The single most helpful radiologic feature, however, is the increase in radiodensity of the entire temporal bone. Polytomography (Fig. 2B) is frequently helpful in de-

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Fig. 1A. Magnification radiograph of temporal bones of a normal brush tail rat. The bullae are well pneumatized and the septae are sharply defined.

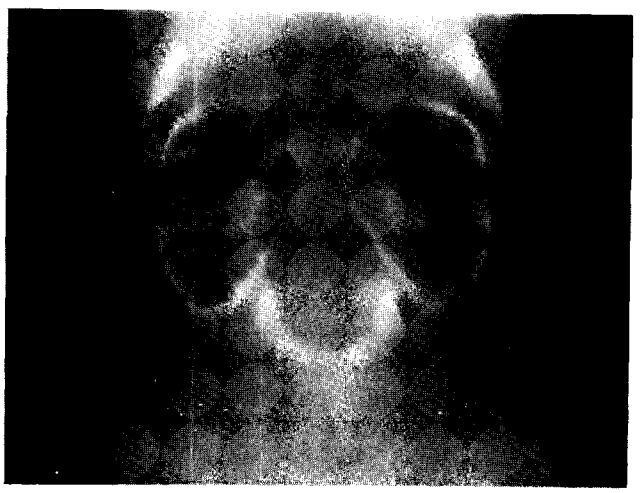

Fig. 1B. Polytomogram confirms the normal appearance of the bulla. The cochlea can be seen protruding into the bulla from the medial aspect of the temporal bones.

fining the anatomy of the ossicles and the cochlea. In this instance note the sclerosis of the temporal bones bilaterally which is a reflection of reactive new bone due to infection. In this section the bulla are filled with pus and there is dramatic thickening of the septa as well as formation of reactive new bone. This extensive ossification is an important cause of the increasing radiodensity although the displacement of air by the products of inflammation aids in producing increased radiodensity.

Occasionally unilateral otitis develops. In Fig. 3A one can see right otitis and a normal left ear. The sclerosis of the temporal bone is confirmed by polytomography (Fig. 3B).

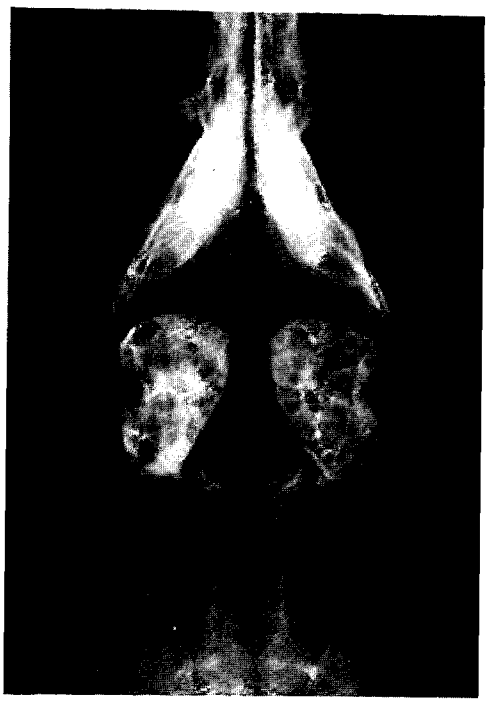

Fig. 2A. Magnification radiograph of temporal bones of a brush tail rat affected with bilateral otitis. The feature that stands out is increased radiodensity of the temporal bones. Note too the decreased pneumatization of the bulla and the lack of sharp definition of the septa.

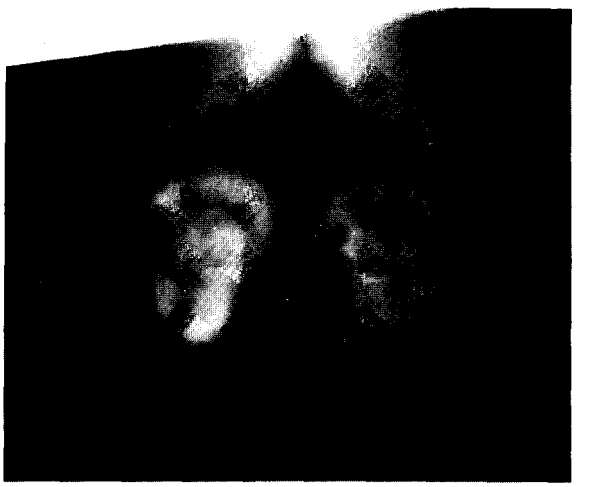

Fig. 2B. Polytomography confirms the presence of sclerotic temporal bones. The basis of the sclerosis is the production of reactive new bone as well as the displacement of air from the bulla by products of inflammation.

The increased radiodensity was shown on section to be due to two major factors: marked sclerosis of all the osseous components of the ear; accumulation of inflammatory exudate within the cavities of the middle ear (Figs. 4A, B). New bone formation was observed on both the internal and external surfaces of the temporal bones and bulla, and there was also a small degree of proliferation of fibrous connective tissue. Both acoustic and vestibular areas were obliterated by this process.

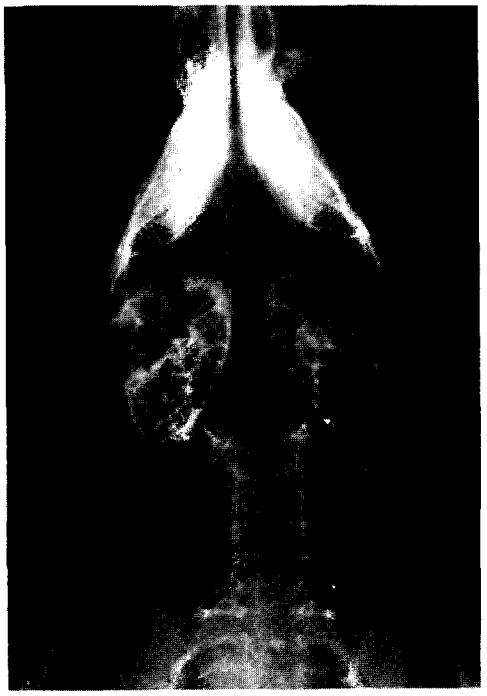

Fig. 3A. Unilateral otitis media is detected radiographically when one temporal bone shows increased radiodensity and sclerosis with thickening of the septa in the bulla. These findings are seen in the right temporal bone (on the reader's left) and may be compared to the normal left temporal bone.

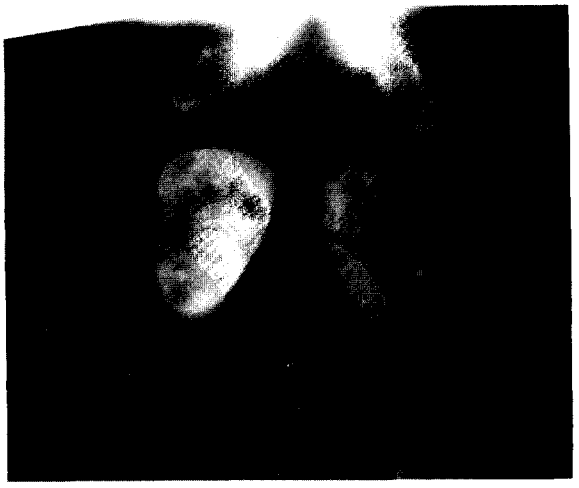

Fig. 3B. Polytomography confirming that the otitis is unilateral. The marked sclerosis of the right temporal bone is even more apparent.

CLINICAL-RADIOLOGIC CORRELATION

Radiography was performed on six brush tail rats with vestibular signs and weight loss as well as four clinically normal brush tail rats. All animals were anesthetized with halothane and nitrous oxide delivered *via* face mask. While anesthetized, blood samples were obtained for a complete blood count. Radiographs were obtained and the ear canal and tympanic membrane were examined. Bacterial cultures were obtained.

The results of the hematologic evaluation showed no leukocytosis even in the presence of extensive otitis.

Fig. 4A. Section of the ear of the brush tail rat illustrated in Figs. 2A and 2B. Note the marked sclerosis and the thickening of osseous components of the ear as well as the accumulation of inflammatory product. These are the features of chronic bilateral otitis. (H & E X3.5)

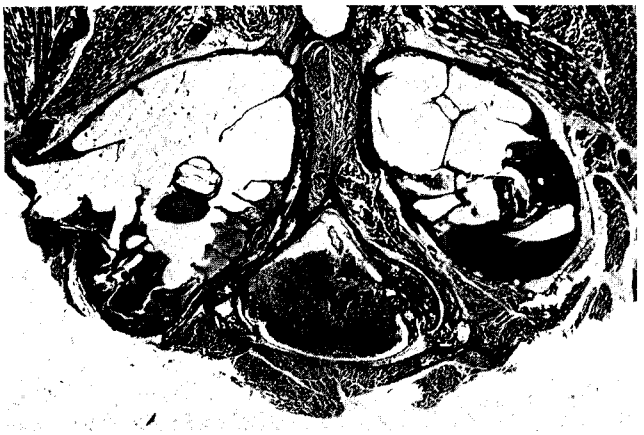

Fig. 4B. The normal ear for comparison shows exquisitely thin, bony septae without new bone formation. No inflammatory products are present in the ear cavity. (H & E X3.5)

The causative organism was *Pseudomonas aeruginosa* which was cultured both at the time of clinical examination and necropsy.

Clinically, the appearance of the tympanic membrane varied from mild hyperemia to dull opacification with a collection of fluid behind it. In one animal the tympanic membrane had ruptured.

DISCUSSION

Otitis media in rats was reported in 1930 (7, 8). In 1934 radiography was recommended for evaluating infectious otitis in rats (4). We have used this technic in our studies.

In 1968 the histopathologic appearance of rat otitis media was described (9).

The comparative pathology of guinea pig and human otitis media has been reviewed (2, 3, 5). Otitis media in a domestic rabbit (*Oryctolagus cuniculus*) was studied with particular reference to *Pasteurella multocida* as the causative organism (1).

In the rat *Mycoplasma pulmonis* is the most frequent cause of otitis media, while in the rabbit it is *Pasteurella multocida* (1). In the guinea pig *Streptococcus zooepidemicus* Group C and *Diploccus pneumonia* were isolated most often, while *Klebsiella pneumonae* was identified occasionally (6).

Our study has confirmed the observation that radiography is exceedingly useful in recognizing otitis in the brush tail rat and in defining the pathologic anatomy (4). It is hoped that this modality will prove useful in following the course of ear disease after treatment to determine whether the changes are reversible.

SUMMARY

Radiographs of the temporal bone of brush tail rats (*Octodontomys gliroides*) affected with otitis were compared with the radiologic anatomy of the normal brush tail rat. Our study confirms that infection can be identified radiographically. Increased radiodensity, thickening of the wall and septa of the bulla with loss of sharp definition, and reactive new bone characterize infection in the temporal bone.

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ZUSAMMENFASSUNG

Die roentgenonologische Diagnose einer krankhaften Entzuendung des Schlaefenbeines der Trichosorus stuetzte sich auf die beobachtete verstaerkte Roentgenstrahlenfestigkeit gegenueber dem Hinterohrknoechelchen, die reaktive neue Knochenbildung und die angesammelten Entzuendungsprodukte innerhalb der Luftzellen. Vergroesserte Roentgenaufnahmen, polytomographische Aufnahmen und Vergleiche mit krankhaftem Gewebe bestaetigten die roentgenologischen Ergebnisse. Da die Trichosorus von Verhaltensforschern oft als Versuchstier benutzt wird, ist die Diagnose von Otitis wichtig. Ausserdem hat die Trichosorus einen aehnlichen Aufbau des Schlaefenbeines wie das Meerschweinchen und dieser Bericht vergleicht das Schlaefenbein der Trichosorus mit dem des Meerschweinchens. Die klinischen Beobachtungen von Otitis bei der Trichosorus waren geneigter Kopf, schwankender Gang und Gewichtsverlust. Der Organismus, der in sechs befallenen Ratten gezuechtet worden ist, war *Pseudomonas aeurginosa*.

RÉSUMÉ

On a basé le diagnostic radiologique d'un désordre inflammatoire du temporel chez le trichorosus sur la détection d'une augmentation d'opacité aux rayons X de la bulle tympanique, une génération osseuse réactive et une accumulation de déchets d'inflammation dans les cellules à air. On s'est servi d'agrandissement radiographique, de polytomographie et de similarité avec des spécimens pathologiques, pour confirmer l'impression donnée par l'observation radiologique. Comme le trichosorus est un animal communément utilisé par les behavoristes, le diagnostic d'otite est important. De plus le trichosirus ressemble au cobaye en ce qui concerne l'anatomie du temporel. Et ce rapport fait une comparaison entre l'anatomie du temporel chez le trichosorus et chez le cobaye. Les observations cliniques de l'otite chez le trichorosus comprennent la tête inclinée, une démarche saccadée et une perte de poids. L'organisme en culture chez les six rats atteints était le *Pseudomonas aeurginosa*.