PEER REVIEWED

Imaging Study of Myringotomy in Dairy Calves

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Abstract

Otitis media is common in dairy calves. Antibiotic treatment alone does not always result in complete resolution. Based on human pediatric medicine experience, where myringotomy tubes are commonly placed to drain purulent accumulations from the ear, it has been suggested that a myringotomy can be performed in calves. We investigated whether performing a myringotomy using a straight rigid instrument (knitting needle) is anatomically feasible in calves. Two imaging techniques and direct visualization were used to observe the trajectory of the needle and its immediate effects on the tympanic membrane. Our study shows there is no anatomic impediment to performing a myringotomy in calves with a straight rigid instrument.

Résumé

L'otite moyenne survient fréquemment chez les veaux laitiers. Le traitement antibiotique seul ne résout souvent pas le problème. Il a été suggéré que la myringotomie pourrait être faite chez des veaux car l'utilisation de tubes de myringotomie pour drainer les accumulations purulentes dans les oreilles se fait couramment chez les patients en médecine humaine pédiatrique. Nous avons voulu vérifier si la myringotomie avec un instrument droit et rigide (une aiguille à tricoter) était anatomiquement possible chez les veaux. Deux techniques d'imagerie et l'observation directe ont été utilisées pour visualiser la trajectoire de l'aiguille et ses effets immédiats sur la membrane tympanique. Notre étude démontre qu'il n'existe pas de barrière anatomique à l'utilisation de la myringotomie chez les veaux à l'aide d'un instrument droit et rigide.

Introduction

Otitis media is a common finding in infections caused by *Mycoplasma bovis* in calves, with or without pneumonia.[4,18] The proposed route of infection is via ingestion of contaminated milk that gains access to the eustachian tubes, and ultimately the middle and inner ear.[3,18] Other bacteria, such as *Pasteurella multocida*, *Mannheimia hemolytica*, *Corynebacterium pyogenes* and *Corynebacterium pseudotuberculosis*, have also been implicated in otitis media,[4,7,14] either alone or as mixed infections with *M. bovis.* Animals affected with otitis media show clinical signs of head tilt, facial paralysis, droopy ears and depression.[4,15,17] A wide range (3-80%) in morbidity of otitis media has been reported,[10,14,19] apparently depending on the presence of chronic or epidemic conditions. Treatment of these calves involves prolonged antimicrobial therapy and anti-inflammatory drugs, but medical treatment alone does not always resolve clinical signs.[4,14-16] Unresolved otitis media can spread to cause otitis interna and meningoencephalitis.[15] Human pediatric patients with recurrent or chronic otitis media are treated both medically and surgically via myringotomy.[1,8,16] To the authors' knowledge, no studies have compared the effectiveness of one method versus the other. A myringotomy implies perforation of the tympanic membrane to allow purulent material to drain, preferably avoiding the middle of the membrane and thus the bones in the inner ear. In human medicine the longer a myringotomy remains open, the lower the recurrence rate.[2] Reported procedures to allow drainage of the accumulated purulent material in the middle and inner ear in calves include myringotomy (as early as 1978)[15] and bulla osteotomy.[17] Although both techniques require complete immobilization of the head of the calf, myringotomy is a much faster and less invasive procedure than bulla osteotomy. Bulla osteotomy requires extensive surgery in the neck region, and very careful avoidance of important nerves and vessels.[17] To the authors' knowledge, no epidemiological studies have been reported about the success rate of either procedure.

The objective of this imaging study was to evaluate any anatomical impediments to performing a myringotomy in calves with a straight and rigid instrument (knitting needle), as previously suggested.[a]

Procedure

Cadaver heads from newborn dairy calves previously used for student instruction in the dystocia laboratory at the University of California School of Veterinary Medicine were used for this imaging study. For each imaging technique a different head was used; one of the tympanic membranes was perforated, while the other one was maintained intact as a control. The perforating instrument was a knitting needle with a diameter of 3.5 mm and a length of 40 cm. The head was positioned in lateral recumbency, and the ear pinna was stretched vertically to avoid bends in the ear canal. The needle was inserted along the ear canal, approximately 3 cm, and upon contact with the tympanic membrane slight pressure was applied to perforate it. Perforation of the tympanic membrane could be felt by the operator as a change in resistance and a crisp sound and sensation; at this point pressure was discontinued and the needle was withdrawn.

Radiographic contrast was the first imaging technique used. After perforating the tympanic membrane, the needle was removed and contrast radiographic material was infused into the ear canal. A total of 2 ml of a barium sulfate suspension[b] was allowed to slide into the ear canal while the pinna was pulled away from the head to facilitate flow to the tympanic membrane. Radiographs were taken in rostro-ventral and lateral views.

The second imaging technique used was computer-aided tomographic scanning (CAT-scan). For this technique, the needle was maintained in position after perforating the tympanic membrane to evaluate its reach into the inner ear and record the needle trajectory.

Finally, direct visualization of the tympanic membrane was performed by sectioning the head on a plane along the needle in place, providing an *in situ* view of the ear canal, tympanic membrane and bulla. The needle was used as a guide.

Results

Figures 1A and 1B show the images obtained using the contrast radiographic technique. In the rostro-ventral view (Figure 1A), there is evidence of tympanic membrane perforation with the knitting needle in the right ear by dissemination of the contrast fluid through the bulla (small black arrows). In the left ear (control), however, the contrast medium stops at the tympanic membrane, clearly delineating the membrane (large black arrow). In the lateral view (Figure 1B), the contrast fluid has disseminated to such extent as to delineate the end of the eustachian tube into the nasopharynx (large white arrow).

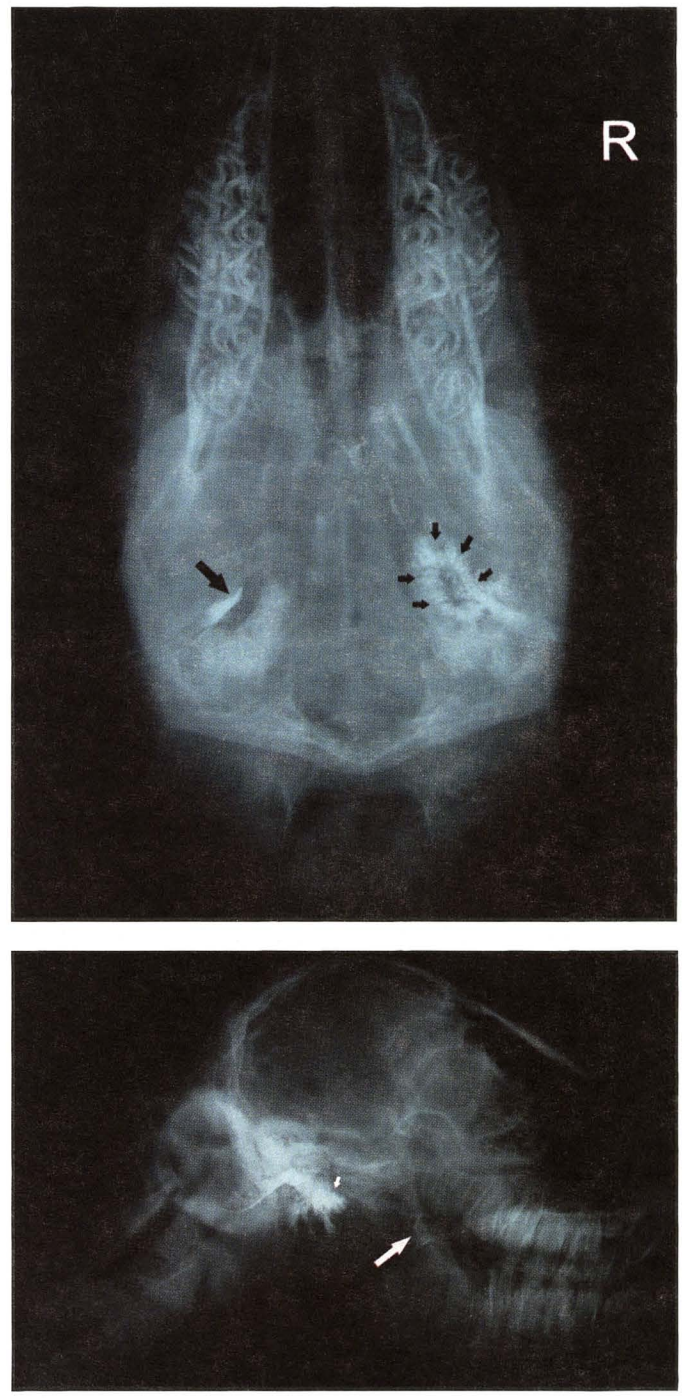

Figure 1. Contrast radiographs of a calf skull with unilateral perforation of the tympanic membrane. **1A** (upper figure) - Comparison of intact tympanic membrane in the left ear (large black arrow) and perforated tympanic membrane in the right ear, as evidenced by leaking of the contrast into the bulla (small black arrows). **1B** - Evidence of leaking of contrast into the bulla (small white arrow) and the eustachian tube outlined by the contrast material (large white arrow).

Figure 2 shows an image of the CAT-scan performed with the needle in place to record the needle trajectory. This image shows that the anatomical structures of the ear allow introduction of a rigid instrument like a knitting needle. The asymmetry in the picture is due to the position needed to allow the needle to fit into the scanner.

Finally, the tympanic membrane was directly visualized by sectioning the head (Figure 3). This procedure verified the imaging studies, and showed that the size of the ear canal allowed a 3.5 mm diameter needle to be used without causing damage along the ear canal. The perforation in the tympanic membrane using a needle this size almost covered the entire surface of the membrane.

Discussion

This imaging study confirms that myringotomy by blind advance of a straight rod is indeed anatomically possible in calves. Studies are needed to evaluate the effect of a myringotomy on drainage of the middle ear and the health and recovery of the calf. It is important to note that proper restraint and sedation must be applied to live calves. Reported complications of myringotomies in children include effusion, hearing loss, atrophy and myringosclerosis.[5,13] Hearing loss is always greater

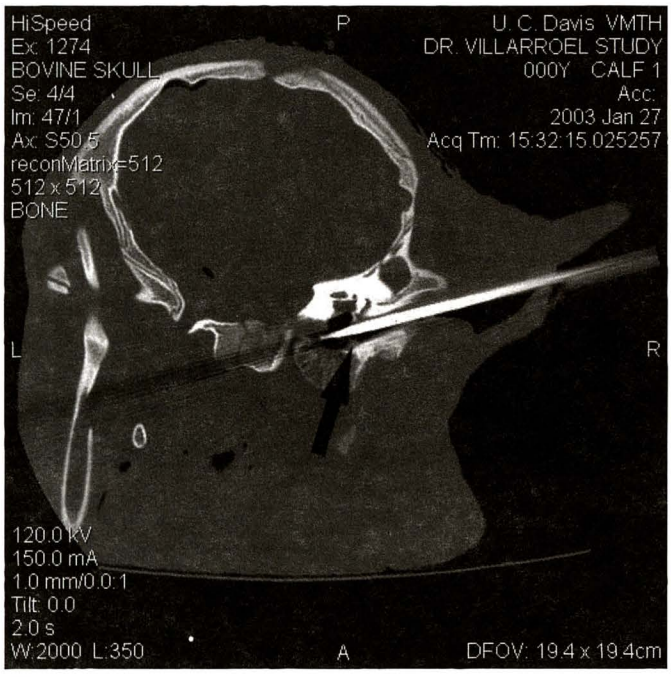

Figure 2. Computer-aided tomographic (CAT) scan of a calf skull with a 3.5 mm diameter metal knitting needle perforating the tympanic membrane (black arrow) and reaching into the bulla.

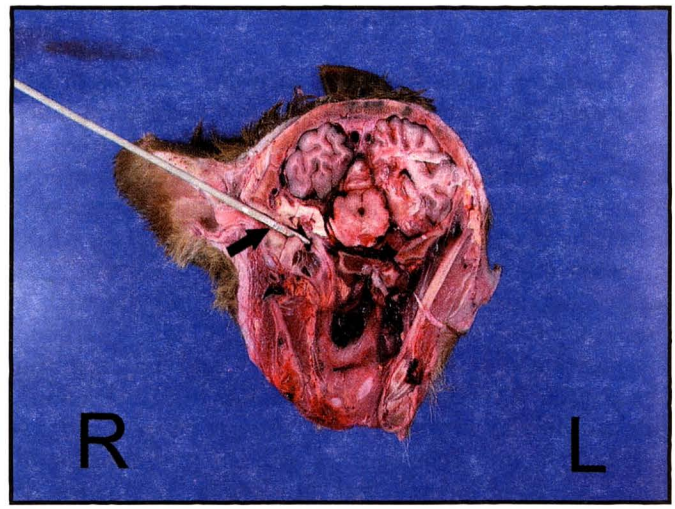

Figure 3. Direct visualization of a myringotomy in the cross-section of a calf skull with a 3.5 mm diameter knitting needle inserted along the ear canal, perforating the tympanic membrane (black arrow).

while otitis media is active,[6] and decreases after treatment. Clinical studies in children show that myringotomy alone may not be enough to resolve the situation, but that concomitant antibiotic treatment is needed.[8,16] Furthermore, it has been suggested that a myringotomy should only be performed in those cases in which medical treatment alone is not sufficient to resolve the disease, and not as a sole intervention.[1,2,8,16]

The main bacterial causes of otitis media in children are *Streptococcus pneumoniae*, *Haemophilus influenza* and *Moraxella catarrhalis*,[9] which differ from those reported in calves. This may be an important factor when comparing the effectiveness of myringotomies in children with that in calves, because the purulent discharge with *Mycoplasma* spp infections is of thick consistency and may not drain easily. In human medicine myringotomies can be performed alone, or with subsequent implantation of a grommet (ventilation tube), although complications do occur and its efficacy has been questioned.[11,12] It seems impractical in bovine medicine to place ventilation tubes, as animals would tend to dislodge them by rubbing their heads against firm objects, causing more damage and potential for foreign body reactions, ongoing infection and inflammation in the ear canal and tympanic membrane. Another consideration is the size of the perforation in the tympanic membrane. In pediatric medicine the main concern is to avoid hearing loss, and therefore the perforation in the tympanic membrane is peripheral and very small. Hearing loss may not be as important in calves, and it may be practical to use a large diameter instrument (3.5 mm) that causes a large perforation in the tympanic membrane.

This should result in a longer period of patency of the perforation, and better drainage of purulent material of thicker consistency.

Conclusions

Our study confirms that there is no apparent anatomical impediment to performing myringotomies with a common-use instrument like a knitting needle. Furthermore, this study implies that a myringotomy may be effective in allowing drainage of middle ear contents both through the external ear and into the pharynx. Studies in live animals are needed to evaluate if purulent material of thick consistency, like that caused by *Mycoplasma* spp infections, can be effectively drained through the eustachian tube by opening a vent with the myringotomy. Clinical signs should improve after a myringotomy by decreasing the pressure that the purulent material applies onto the tympanic membrane, and therefore decreasing pain. As this purulent material drains from the infection site, it should promote faster healing. Further controlled experimental studies are needed to evaluate whether myringotomies can aid practitioners in treating calves that have otitis media by shortening the time of treatment and improving the clinical outcome.

Endnotes

[a] Schnepper R: Practice Tips at the American Association of Bovine Practitioners 2002 Annual Conference, Madison, Wisconsin.

[b] Medebar Plus Barium Sulfate Suspension "NDC 59081-737-19", Lafayette Pharmaceuticals, Inc, Lafayette, Indiana.

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