Surgical management of 2 different presentations of ear canal atresia in dogs

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Abstract — A 6-year-old French spaniel and a 14-month-old German shepherd dog were diagnosed with ear canal atresia. Based on presentation, computed tomography, and auditory function evaluation, the first dog underwent excision of the horizontal ear canal and bulla curettage, and the second underwent re-anastomosis of the vertical canal to the external meatus. Both dogs had successful outcomes.

Résumé — Gestion chirurgicale de deux différentes présentations de l’atrésie du conduit auditif chez les chiens. L’atrésie du conduit auditif a été diagnostiquée chez un Épagneul français âgé de 6 ans et un chien Berger allemand âgé de 14 mois. En se fondant sur la présentation, une tomodensitométrie et une évaluation de la fonction auditive, le premier chien a subi l’excision du conduit auditif horizontal et un curettage de la bulle et le deuxième chien a subi une re-anastomose du conduit vertical jusqu’au méat acoustique externe. Le traitement des deux chiens fut une réussite.
bacterial cultures were negative. A computed tomography (CT) scan of the head was performed under general anaesthesia. The right horizontal ear canal was filled with material of soft-tissue attenuation and was markedly dilated. The corresponding vertical ear canal appeared normal but ended abruptly at its junction with the horizontal canal. The right bulla was also filled with material of soft-tissue attenuation and its wall was irregular and thickened (Figure 1), compatible with chronic otitis media and osteitis of the bulla. The presumptive diagnosis was ear canal atresia at the junction of the horizontal and vertical ear canals leading to dilation and impaction of the horizontal canal and bulla with cerumen.

A brainstem auditory evoked response (BAER) tracing was obtained under sedation, using previously described methodology (10,11). With the patient in sternal recumbency, subcutaneous scalp electrodes were attached in a specific pattern and specialized ear plugs were inserted. Each ear was separately stimulated by air-conducted stimuli in the form of clicks at 80 and 100 decibels (dB), while the non-stimulated ear received a “masking” noise. Tracing was normal when the left ear was stimulated, but all waves were absent at both 80 and 100 dB for the right side, indicating complete deafness (10).

The dog was prepared for surgery. Cefazolin (Cefazolin; Sandoz, Quebec), 20 mg/kg body weight (BW), IV, q2h was administered, starting 30 min before the first incision. A lateral approach to the ear canal was made and allowed exposition of the blunt end of the vertical ear canal and the dilated horizontal ear canal (Figure 2). The vertical ear canal was left in situ. A horizontal ear canal ablation and lateral bulla osteotomy were performed and the accumulated brown secretions and the lining of the tympanic bulla were removed by curettage. The surgical site was lavaged and an active drain (butterfly catheter inserted into a vacutainer) was placed around the bulla for 2 d. Closure was completed routinely. Postoperative analgesia was provided by constant rate infusion of fentanyl (Fentanyl 250 μg/5 mL; Sandoz), 3 μg/kg BW per hour and ketamine (Vetalar 100 mg/mL; Bioniche, Belleville, Ontario), 0.25 mg/kg per hour for the first 24 h. The dog recovered uneventfully and was discharged 2 d after the surgery. Meloxicam (Metacam 1.5 mg/mL; Boehringer Ingelheim, Burlington, Ontario), 0.1 mg/kg BW, q24h, tramadol (Tridural; Labopharm, Laval, Quebec), 4 mg/kg BW, q12h and cefalexin (Novo-Lexin; Novopharm, Toronto, Ontario), 30 mg/kg BW, q12h were prescribed for 10 d.

The results of histopathological examination of the excised canal and middle ear content were consistent with diffuse...
parietal inflammation and intraluminal cerumen, without any evidence of septic or neoplastic processes. At the 4-month recheck, the wound was completely healed, the vestibular deficits had completely resolved, but the facial nerve paralysis remained. Another CT-scan was performed, which showed that the right bulla was filled with a heterogeneous soft-tissue and bone material (*) and there is remodelling of the wall with evidence of cortical disruption (arrowhead), suggestive of focal lytic foci.

**Case 2**

A 14-month-old intact male German shepherd dog was presented for right otalgia. Atresia of the right external opening of the auditory canal had been diagnosed at 2 months of age and left untreated. Physical examination was unremarkable except for the absence of an auditory canal opening and a painful, firm swelling corresponding to the vertical ear canal (Figure 4). A CT scan of the head was performed under general anaesthesia. The right horizontal and vertical ear canals were moderately distended and filled with material of soft tissue attenuation. The vertical ear canal distally ended abruptly without evidence of the external acoustic meatus (Figure 5). The corresponding bulla was also partially filled with material of soft tissue attenuation but showed no other abnormalities. A presumptive diagnosis of right ear canal atresia at the level of the auditory canal opening, with cerumen accumulation in the dilated ear canal was made.

The dog was prepared for surgery. Cefazolin (20 mg/kg BW, IV, q2h) was administered, starting 30 min before the

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**Figure 3.** Four months postoperative transverse computed tomography image of the head with a non-contrast (A) high-pass filtered image (W/L = 3000/300) and (B) low-pass filtered image in case 1 (W/L = 250/100). The right bulla is filled with a heterogeneous soft-tissue and bone material (*) and there is remodelling of the wall with evidence of cortical disruption (arrowhead), suggestive of focal lytic foci.

**Figure 4.** A 14-month-old German shepherd dog with atresia of the right external opening of the auditory canal and swelling corresponding to the vertical ear canal (case 2).

**Figure 5.** Transverse axial (1.3 mm) precontrast computed tomography image (W/L = 2000/0) at the level of the vertical ear canal depicting the aural atresia (*) at the junction of the vertical ear canal filled with soft-tissue attenuation (Δ) and the pinna (arrow) in case 2.
first incision. A lateral approach to the ear canal was made. The vertical portion of the canal was freed from its muscular attachments and the blind end of the canal was resected to leave a round-ended structure. The brown ceruminous content of the canal and bulla was removed by curettage and flushing. An elliptical full thickness incision was made along the ridge of the tragus and the anthelix matching the size of the opened ear canal. Blunt dissection was performed from the elliptical incision to the vertical ear canal in order to bring it to the recipient site using a pull-through technique. The cartilage and skin of the pinna were sutured to those of the opened vertical ear canal with simple interrupted sutures of polydioxanone 3/0 (PDS II; Ethicon, Guaynabo, Puerto Rico) (Figures 5 and 6). The surgical site was lavaged and closed routinely.

For technical reasons, the brainstem auditory evoked response (BAER) testing was performed at that time, using the same methodology as previously described: the response was normal on the left side whereas on the right side, waveforms although present had abnormal morphology, latencies and amplitudes indicating minimal hearing at 80 dB and slight hearing at 100 dB (Figure 7). Wave amplitudes recorded at 80 dB were severely decreased to almost null, but were improved at 100 dB, suggesting a conduction disturbance of hearing (10). Latency from sound stimulus to the appearance of wave I was prolonged at 80 dB and 100 dB, although improved at 100 dB, also suggesting a conduction disturbance (10). Although difficult to assess, interwaves latency was not significantly different from the left ear, excluding a brainstem lesion (10).

Postoperative analgesia was provided by hydromorphone (Hydromorphone hydrochloride; Sandoz), 0.05 mg/kg BW, q4h as needed for the first 24 h. The dog recovered uneventfully and was discharged 2 d after the surgery. Meloxicam, 0.1 mg/kg BW, q24h and tramadol, 4 mg/kg BW, q12h were prescribed for 7 d. Rechecks done at 2 wk and 3 mo revealed a completely healed wound, absence of otalgia, and unremarkable otoscopic examination except for a slightly narrowed auditory meatus compared with that immediately after surgery (subjectively judged as originating from a mediolateral collapse of the flaccid cartilage rather than a true stenosis), and mild ceruminous accumulation in the right horizontal and vertical portion of the ear canal (Figure 8). Brainstem auditory evoked response tracings showed improvement of the hearing function over time: interwaves latency was still comparable to the contralateral side and latency from sound stimulus to wave I was still increased but waveform amplitudes increased, although still smaller than normal (Figure 9).

**Discussion**

During embryogenesis, the primitive ear canal is gradually occluded by epithelial overgrowth of its walls, so that it is functionally closed at birth. In the dog, the ear canal is patent again from 10 days of age (12). Failure of embryological development of the ectoderm tube or failure of the ear canal to become patent after birth will lead to a congenital atresia of the external ear canal. During adulthood, traumatic separation of the ear canal can result in acquired ear canal atresia. In this case, the auditory canal usually ruptures at the junction between the auricular and annular cartilages (8,9).

Schmidt et al (5) reported a case of external auditory canal atresia occurring at the junction of the vertical and horizontal ear canals of probable congenital origin based on the absence of bacteria from culture, the absence of previous clinical signs, the lack of signs of previous trauma and abnormal accumulation of sterile ceruminous material in the auditory canal. Based on the same rationale, the aural atresia in our first dog could represent a segmental congenital defect. However, an unknown traumatic origin leading to separation of the vertical and horizontal ear canal may be a more typical origin for an atresia at this location. Signs of trauma can be subtle and overlooked, subsequent ear carriage can be normal, and absence of a known traumatic event as reported by the owner is not conclusive evidence of absence of trauma (8,9). Although rare, these cases emphasize the importance of a thorough otoscopic evaluation during routine examination. The negative culture from the horizontal ear canal could suggest that the external ear canal never opened and remained sterile, supporting a congenital origin. However, negative results could also come from lack of viable bacteria.
in the retrieved sample, sampling or processing errors, and, as culture was not repeated intraoperatively, are not conclusive of a historical absence of bacteria. Given the location of the atresia, the second case was hypothesized to be congenital in origin, although a culture from the ear canal would have been ideal.

Dilation and impaction of the canal and middle-ear with ceruminous material may lead to a variety of signs ranging from local swelling and otalgia (1,2,5,6), as seen in the second dog, to middle-inner ear disease with peripheral vestibular signs (4), as in the first dog, most probably depending on the chronicity of the disease. The first dog also exhibited facial paralysis which has not been reported in previous cases of aural atresia. It could have been secondary to chronic inflammation and injury to the portion of the facial nerve that lies adjacent to the tympanic bulla, within the facial canal in the petrosal portion of the temporal bone. Alternatively, a facial nerve neurotmesis could have occurred during the original unknown trauma causing the canal separation and facial nerve paralysis concurrently.

A CT scan is the modality of choice for evaluation of ear diseases in dogs and cats (13), although positive-contrast ear canalography and magnetic resonance imaging (MRI) can also be beneficial (6,8). In our patients, CT scanning was essential for evaluation of the ear canal’s anatomy to precisely diagnose the type of atresia. To the author’s knowledge, this is the first description of CT scan findings in a case of ear canal atresia at the junction of the horizontal and vertical portions of the ear canal. The CT scan proved to be a valuable tool to accurately evaluate the appearance of the ear canal (location, severity of the dilation); the secondary changes to the bulla and findings were similar to those of another report (5). To our knowledge, no study has addressed the CT scan or MRI appearance of the tympanic bulla following osteotomy. Such information would be useful to determine the clinical relevance of post-bulla osteotomy CT-scan or MRI findings in cases with incomplete recovery, persistent clinical signs, or suspected recurrence. Given the excellent recovery and the absence of recurrence more than 1 y after the surgery, the chronic changes observed in the follow-up CT scan of the first dog probably represent a normal post-osteotomy remodelling. This is in agreement with 2 studies documenting gross and microscopic healing after experimental total ear canal ablation with lateral bulla osteotomy or ventral bulla osteotomy alone (14,15). It was shown that healing may be variable with obliteration of the tympanic cavity by fibrous connective tissue and/or proliferating subperiosteal new bone and/or granulation tissue, or partial or complete re-formation of the bulla with subsequent accumulation of keratinized debris.

Brainstem auditory evoked response is an objective, reliable, easy to perform and noninvasive method to assess auditory function in dogs. Wave morphology, latency, and amplitude can be evaluated; however, latencies differ between different breeds (with different head size) and amplitude is highly variable making their comparison to normative data difficult (11). Interaural comparison might, therefore, be more reliable when one ear is known to be normal. The first dog had flat BAER recordings of the involved ear, both at 80 dB and 100 dB, which is typically seen in cases of congenital sensorineural deafness (10). The second dog had waveform characteristics suggestive of a conduction disturbance: wave amplitudes were almost null at 80 dB but improved at 100 dB and latency from sound stimulus to the appearance of wave I was prolonged at 80 dB and 100 dB (10). However, only air-conducted BAER testing was performed, therefore, making investigation of the type of deafness (sensorineural or conductive) impossible. Although a conductive component was likely in both cases, given the aural atresia and the associated outer and middle ear abnormalities (“air-bone gap”), bone-conducted BAER testing would have been ideal to help investigating the sensorineural part, as inner ear anomalies have been reported in human cases of congenital aural atresia (16).
Historically, it was postulated that each BAER wave could be attributed to a single neural generator. Although it has been shown to be true for waves I (cochlear portion of the vestibulocochlear nerve) and II (cochlear nuclei in the medulla), it is now known that the other waves receive contribution from more than one anatomic structure, making BAER abnormalities unreliable to anatomically localize a lesion (10,11). Another limitation is the timing (postoperative) of the BAER testing in the second dog, due to the absence of the external acoustic meatus. It has been shown that total ear canal ablation with lateral bulla osteotomy leads to complete and irreversible hearing loss except when the tympanic membrane and ossicles were retained, whereas ventral bulla osteotomy has no deleterious effects on hearing as assessed by air-conducted BAER testing (14,15). It is therefore possible that the surgery could have been the cause of the decreased auditory function in the second dog. However, we think that it was a true representation of the disease process as the tympanic membrane was most probably already ruptured before surgery due to cerumen impaction and ossicles and auditory canal were preserved. The auditory function improvement seen over the 3 mo following surgery is believed to have resulted from the creation of a normal air-filled external and middle ear and formation of a pseudo-tympanic membrane.

Various surgical techniques have been reported to correct ear canal atresia: lateral wall resection (1,2), anastomosis of the vertical canal to the external meatus location using a pull-through approach (5), primary repair with anastomosis of the vertical and horizontal ear canal (8), suturing of the surgically opened horizontal ear canal to the skin without addressing the vertical ear canal (9), total ear canal ablation and lateral bulla osteotomy (3,4), and vertical canal ablation (7). However, no clear decision-making process has been previously outlined to choose one procedure over another. The choice of the surgical approach should probably be based upon a number of factors: the location of the atresia, the degree of changes of the external ear canal and the presence or absence of otitis media as assessed by diagnostic imaging, the presence or absence of neurological signs, the auditory function with its conductive and sensorineural components as evaluated by BAER testing and the chronicity of the lesions (age of the animal for congenital atresia, or time from suspected trauma to diagnosis for acquired atresia). This choice should also take into account the risks related to each surgery (wound dehiscence or infection, ear canal stenosis, recurrence), the postoperative appearance and its acceptance by the owner. In our first case, excision of the horizontal ear canal with lateral bulla osteotomy and curettage was chosen. A ventral bulla osteotomy would have been another option although access to the dilated horizontal ear canal was, however, left in situ to decrease surgical trauma and for cosmetic purpose.

In our second case, reconstruction of the ear canal with anastomosis of the vertical canal to the external meatus location was privileged based on the location of the atresia, the absence of neurological signs, the mild changes of the external and middle ear, and the potential residual hearing function. The hearing function in this dog would be preserved or improved and we hypothesize that the mild inflammatory changes in the middle/external ear would resolve once drainage had resumed. This procedure has only been described twice for ear canal atresia (5,6) and provided excellent results in our case, with full resolution of the clinical signs and significant auditory function recovery. This was illustrated by the improvement of wave amplitude in the follow-up BAER recordings, which, to our knowledge, has not been reported previously. Total ear canal ablation was not considered as it would have eliminated any potential auditory function recovery. Lateral wall resection or vertical canal ablation were other possible options although the cosmetic effect would not have been as good. It is unknown if these procedures would be more prone to wound complication. One potential complication of the procedure we performed is stoma stenosis with subsequent recurrent otitis externa. Although the surgically obtained auditory meatus was slightly narrower than the contralateral, no related complications were experienced in the relatively short follow-up in this case.

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References


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**Answers to Quiz Corner**

Les réponses du test éclair

1. **a)** The facial nerve runs along the side of the face, and damage to this nerve could cause these signs.
   
   a) Le nerf facial est situé sur le côté de la face et une atteinte à ce nerf peut causer les signes décrits.

2. **b)** Neonates with lung lesions may have normal respiratory sounds. Radiographs and arterial blood gas analysis provide information on structure and function.
   

3. **e)** With this maneuver, stomach inflation/deflation can be mistaken for chest excursion.
   
   e) Avec cette manœuvre, le gonflement/dégonflement de l’estomac peut être confondu avec l’excursion du thorax.

4. **d)** Assessment of pulse quality does not enable you to estimate systolic or diastolic pressure.
   
   d) L’évaluation de la qualité du pouls ne vous permet pas d’estimer la pression systolique ou la pression diastolique.

5. **a)** Mares normally cycle during periods of longer day length, which, in the Northern hemisphere, is in the spring (March to July).

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1. **a)** The facial nerve runs along the side of the face, and damage to this nerve could cause these signs.
   
   a) Le nerf facial est situé sur le côté de la face et une atteinte à ce nerf peut causer les signes décrits.

6. **a)** The dog’s age and the chronic clinical course strongly suggest a nasal tumor.
   
   a) L’âge du chien et la nature chronique suggèrent fortement une tumeur nasale.

7. **d)** The pelvic limbs are extended, with the femoral head rotated medially.
   
   d) Les membres pelviens sont placés en extension, avec la tête des fémurs tournée médialement.

8. **e)** These findings describe petechial hemorrhages.
   
   e) Cette description correspond à des hémorragies pétéchiales.

9. **d)** Thrombocytopenia is the most likely cause of this problem.
   
   d) Une thrombocytopenie est la cause la plus probable de ce problème.

10. **d)** Selenium deficiency does not affect the digestive system.
    
    d) Une carence en sélénium n’affecte pas le système digestif.