



A Pandora's box in feline medicine: presenting signs and surgical outcomes in 58 previously hoarded cats with chronic otitis media-interna

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Abstract

Objectives The aim of the present study was to report clinical findings, surgical complications and outcomes for previously hoarded cats treated surgically for otitis media-interna (OMI) and to investigate the risk factors for complications and poor outcomes.

Methods A retrospective study was conducted of 58 cats from an institutional hoarding environment that underwent ventral bulla osteotomy (VBO).

Results Inappetence was uncommon at presentation (9/58, 16%) compared with pruritus/alopecia (50%), nasopharyngeal signs (45%), otitis externa (OE) (79%) and otitis interna (OI) (ataxia ± head tilt/head excursions) in 40%. Purulent aural discharge occurred in 36% and polyps in 26%. The tympanic bulla wall was moderately or severely thickened radiographically in 38/108 (35%) ears. Cultures were positive for *Streptococcus equi* subspecies *zooepidemicus* in 26/48 (54%) cats. Of the 58 cats, 40 (69%) had complications after the first VBO and 19/30 (63%) after the second. Of 101 complications, 56 (55%), from 27/88 (31%) surgeries, were considered serious, including life-threatening perioperative complications in seven, OI in eight, prolonged anorexia in six and worsening of pruritus/alopecia in nine cases. Three cats developed xerostomia (dry mouth) after the second VBO. Pruritus/alopecia, nasopharyngeal signs, OE and purulent aural discharge resolved in a statistically significant proportion of cats but persisted in some. Full resolution of OI was uncommon. OI preoperatively, and surgery performed by a generalist (vs specialist) surgeon, were risk factors for OE at recheck (OI: odds ratio [OR] 4.35; 95% confidence interval [CI] 1.21–15.70; $P=0.02$; surgery: OR 3.64; 95% CI 1.03–12.87; $P=0.045$). No other prognostic indicators were identified. No variables tested were significantly associated with risk of serious complications or euthanasia.

Conclusions and relevance Surgical management of chronic OMI was successful in most cases but was not benign and not always beneficial. The analysis was unable to identify clinically helpful outcome predictors. Optimal management of chronic feline OMI remains a challenge, particularly for animal shelters. Less invasive approaches and chronic medical management require further investigation.

Keywords: Otitis media; otitis interna; ventral bulla osteotomy; surgery; animal hoarding; complications; outcomes; *Streptococcus equi* subspecies *zooepidemicus*

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Introduction

Feline otitis media (OM) can be a challenging diagnosis because it lacks specific clinical signs and often manifests

Correction (September 2023): The paper was updated to correct a sentence in the Conclusions: "Conservative medical management of OMI could be considered, with surgery reserved for cases in which there are quality of life concerns that might reasonably be expected to be ameliorated by VBO."

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as upper respiratory disease or otitis externa (OE).^{1,2} It is most often associated with ascending infection from the nasopharynx through the auditory (Eustachian) tube^{1,3} and may extend to cause otitis interna (OI).^{1,4,5} This causes the classic signs of peripheral vestibular disease (PVD) (nystagmus, head tilt/excursions and ataxia)^{2,4} that are likely to trigger suspicion of OM.

Stress and overcrowding predispose to upper respiratory infection (URI) in cats.^{6,7} Hoarding environments are high risk for chronic upper respiratory disease complex,⁸⁻¹⁰ which can involve the nasal passages, nasopharynx, auditory tubes, paranasal sinuses and middle ear (for reference, see https://fankhauserblog.files.wordpress.com/1993/04/cat_head_xs_p4183384lbd.jpg and <https://teachmeanatomy.info/head/organs/the-nose/paranasal-sinuses/>).¹¹ Undiagnosed otitis media-interna (OMI) is common in cats with rhinitis,^{11,12} and concurrent sinonasal disease^{1,11,13,14} complicates the management of chronic OMI.

Surgical management has been reported for polyps,^{15,16} failed medical therapy,^{17,18} opacity in the tympanic cavity, thickening of the bulla wall and chronic OM.^{5,19} When surgery is deemed necessary, ventral bulla osteotomy (VBO) is the surgery of choice in cats. This requires advanced surgical expertise, is expensive and time-consuming, and can be associated with significant complications.^{15-17,19-22}

Chronic feline OMI is a Pandora's box ('a source of great and unexpected troubles') for animal shelters. Failure to identify OMI has implications for both cats and adopters, but overdiagnosis is also a risk, and clinical management is problematic. There are no evidence-based guidelines for feline case management, nor are reliable prognostic indicators available.

It was the authors' hope that this study would help resolve some of the decision-making dilemmas associated with chronic OMI. The aims of the present study were to report presenting signs, postoperative complications and outcomes in 58 previously hoarded cats treated surgically for OMI, and to identify the risk factors for complications and poor outcomes.

Materials and methods

Animals and study design

This retrospective observational study examined the records of cats from a single institutional hoarding environment (IHE)^{10,23} that were transferred to Toronto Humane Society (THS) between February 2017 and April 2019. THS is a large urban shelter, with a fully equipped veterinary hospital. Routine intake procedures included core vaccination, Wood's lamp screening retroviral screening and treatment with selamectin and pyrantel.

OMI associated with *Streptococcus equi* species *zooepidemicus* (SEZ) had previously been encountered in cats from another IHE. The index of suspicion was therefore high, and intake procedures included careful

assessment for OMI. Shelter protocols for OMI and polyps were followed for suspected cases and included general anesthesia, otoscopic examination, examination of the nasopharynx for a polyp and radiographs of the tympanic bullae. CT was performed at a referral hospital on a case-by-case basis. Cultures were performed at the veterinarian's discretion.

Cats were included if they originated from the same IHE, had been diagnosed with OMI and met the following retrospective confirmatory criteria: (1) clinical findings consistent with OMI; (2) diagnosis by a shelter veterinarian; and (3) bulla disease identified by either CT scan and/or radiographs interpreted by a boarded veterinary radiologist (SM), and/or visual confirmation at the time of VBO.

Case management

Initial therapy for all cases consisted of a broad-spectrum oral antibiotic and tris-EDTA-enrofloxacin-dexamethasone eardrops compounded in-house (tris-EDTA 9.8 ml, enrofloxacin [50 mg/ml]; 1.66 ml, dexamethasone phosphate [5 mg/ml] 0.32 ml). Prednisolone was prescribed as recommended for polyps,²⁰ and case by case at the clinician's discretion for cats without polyps. Dexamethasone was administered perioperatively in selected cases. This was initially to help manage airway edema and subsequently to attempt to prevent it. There were no fixed criteria, and administration was based on the surgeon's risk assessment. VBO surgeries were initially performed in-house, and subsequently by boarded surgeons at referral facilities. A protocolized veterinary examination (see file 1 in the supplementary material) was performed, typically under sedation, to assess the result of each VBO surgery. Results were recorded for the recheck time point as close as possible to 4 weeks after the final VBO.

Clinical findings and outcome measures

Preoperative findings were retrospectively classified (Table 1; see file 2 in the supplementary material for criteria). The case definition for OI/PVD was presence of head tilt/excursions and/or ataxia. Tympanic bulla wall thickening was scored by a boarded radiologist (SM). Surgical complications were classified based on a study by Smeak.²¹ Complications were classified as serious if they were life-threatening, had functional consequences, and/or required intensive or prolonged care. Poor surgical outcomes were euthanasia, serious surgical complications and/or moderate/severe nasopharyngeal (NP) signs, moderate/severe OE or presence of OI at the postoperative recheck.

Data analysis

Data analysis used Microsoft Excel and MedCalc (https://www.medcalc.org/calc/odds_ratio.php). To create dichotomous variables for statistical analysis, mild

Table 1 Clinical features of otitis media-interna before ventral bulla osteotomy surgery in 58 cats transferred from an institutional hoarding environment

Variable	Classification	n (%)
Inappetence	Mild/moderate	5 (8.6)
	Severe	4 (6.9)
Pruritus/alopecia	Localized	12 (21)
	Generalized	17 (29)
Nasopharyngeal signs*	Moderate	25 (43)
	Severe	1 (1.7)
Otitis externa*	Moderate	35 (60)
	Severe	11 (19)
Aural discharge type	Dark/ceruminous	30 (52)
	Purulent	21 (36)
Tympanic membrane†	Bulging, inflamed	13 (11)
	Ruptured	20 (17)
	Not visualized	35 (30)
Polyp‡	Aural	6 (10)
	Nasopharyngeal	6 (10)
	Both aural and nasopharyngeal	3 (5.2)
Radiographic bulla wall thickening§	Moderate	27 (25)
	Severe	11 (10)
Horner's syndrome		1 (1.7)
Nystagmus		1 (1.7)
Otitis interna (peripheral vestibular signs)	Head tilt/excursions	22 (38)
	Ataxia	1 (1.7)
Meningoencephalitis		1 (1.7)

*For outcomes analysis, mild changes were grouped with normal findings for these variables

†n = 116 ears

‡Polyps were found in the bulla at surgery in an additional three cats

§n = 108 ears (four cats had CT only)

NP signs, OE and bulla wall thickening were grouped with normal findings, and other abnormal categories were grouped together (for example, moderate and severe NP signs) (see file 2 in the supplementary material). McNemar's test was used to test the null hypothesis that VBO did not result in resolution of clinical signs. ORs were used to quantify univariable relationships between factors relevant to clinical decision-making and outcomes/complications and were tested for significance using the Pearson χ^2 test. Significance was set at $P < 0.05$.

Results

Study population

In total, 669 cats were transferred from the IHE during the study period. OMI was suspected in 95 (14%) cats and confirmed in 70. Nineteen cats with unconfirmed OMI were euthanized before confirmation, and six did not meet the case definition. Of the 70 cases, 59 were treated surgically and 11 medically. One was excluded because of surgical complications unrelated to OMI, leaving 58. The time from intake to surgery varied, but all cats received medical treatment before surgery.

Presenting signs and clinical findings

Of the 58 cats, 18 (31%) were feline immunodeficiency virus (FIV)-positive on point-of-care testing. Ear

mites were suspected in 20/58 (34%) because of the nature of the aural exudate. The exudate from seven cats was examined microscopically and was positive for *Otodectes* mites in two. Mites were visualized on otoscopic examination in one cat.

Nine cats (16%) exhibited inappetence (Table 1). Half had pruritus and/or alopecia, which extended beyond the head and neck in 17 ('generalized'). In total, 26 (45%) cats had moderate/severe NP signs. Moderate/severe OE was common (46/58, 79%), with purulent discharge in 21 (36%) cats. Polyps were found in 15 (26%) cats. The tympanic membranes (TMs) were bulging/inflamed in 13/116 (11%) ears and ruptured in 20 (17%). Radiographically, there was increased opacity in one or both compartments of the tympanic cavity in 99/108 (92%) ears. The bulla wall was thickened in 98 (91%) ears. Thickening was mild in 60 (56%) ears, moderate in 27 (25%) and severe in 11 (10%) (Figure 1). Horner's syndrome and nystagmus were uncommon (1/58 each, 1.7%). OI was present in 23 (40%) cats, of which 22 had head tilt/excursions.

A total of 81 bacterial cultures were performed for 48 cats (15 ear canal, nine nasal, two pharyngeal, 33 from the bulla at the first VBO, 20 from the bulla at the second VBO and two from the bulla at revision surgery) (manuscript in preparation). Of 48 cats, 26 (54%) had at least one

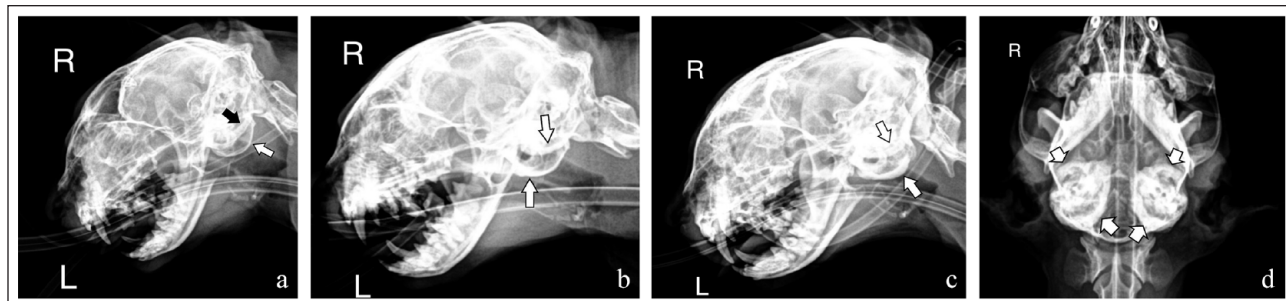


Figure 1 Radiographic images showing otitis media in previously hoarded cats. (a) Cat 10: left dorsal-right ventral oblique radiograph of the skull, showing mild bony thickening of the left tympanic bulla (white arrow) and severe bony thickening of the right tympanic bulla (black arrow) superimposed on the skull. (b) Cat 63: left dorsal-right ventral oblique radiograph of the skull, showing moderate bony thickening of both tympanic bullae (white arrows). (c) Cat 18: left dorsal-right ventral oblique radiograph of the skull, showing severe bony thickening of both tympanic bullae (white arrows). (d) Cat 58: ventrodorsal radiograph of the skull, showing severe bony thickening of both tympanic bullae (white arrows)

SEZ-positive culture and 8/48 (17%) had cultures that were exclusively positive for other species. There was no growth for 14/48 (29%) cats.

Surgical complications

Two of three cats that underwent simultaneous bilateral VBOs developed postoperative airway obstruction. One had multiple subsequent complications (wound abscess, aspiration pneumonia and prolonged anorexia) and the other developed prolonged anorexia. Both cats ultimately recovered. All subsequent bilateral VBOs were staged and performed at least 2 weeks apart.

Unilateral VBO was performed in 25/58 (43%) cats, staged bilateral in 30 (52%) cats and simultaneous bilateral in three (5.2%) cats. In total, 26 surgeries were performed by shelter veterinarians and 62 by specialist surgeons. Of the 58 cats, 40 (69%) had 65 complications after the first VBO and 19/30 (63%) had 36 complications after the second (Table 2). Of 101 complications, 56 (55%), from 27/88 surgeries (31%), were serious. The most frequent serious neurological complication was OI, in eight (14%) cats. Horner's syndrome occurred in 41 (71%) cats and 52/88 (59%) surgeries and occurred after both VBOs in 11 cats.

Life-threatening perioperative complications occurred in six cats at the first VBO and one at the second VBO (7/88 surgeries; 8%). One was euthanized after cardiac arrest. A second cat that arrested developed Horner's syndrome and OI but improved and survived to adoption. One cat required an emergency tracheostomy but survived to adoption. Presumptive meningoencephalitis (ME) occurred in two cats: acutely in one cat 2 weeks after VBO; and 2 months after VBO in the other. Both were euthanized. In the first case, ME was probably present before surgery and may have been acutely exacerbated.

Six cats developed prolonged anorexia postoperatively. These cats sometimes showed interest in food, with initial prehension but subsequent dropping of the food. Three of the six cats developed brown discoloration of the

tongue (Figure 2). Diagnostics were performed in one of these three, and showed neutrophilic inflammation with multiple organisms, including pigmented fungi, and a *Candida*-positive culture. The tongue discoloration was suspected to be secondary to xerostomia (dry mouth) and yeast overgrowth. The three affected cats were treated with oral itraconazole, topical pilocarpine and oral rinses of chlorhexidine or povidone-iodine, as well as esophagostomy tube feeding in two cats. The tongue discoloration resolved in all three cats, but subsequently recurred in one. This cat was euthanized after a complicated and prolonged clinical course.

Severe, generalized pruritus occurred in nine cats postoperatively. At the postoperative recheck, this had resolved in four cats (at intake, alopecia/pruritus was absent in three and localized in one of these four), improved in two cats (localized alopecia/pruritus was present at intake and recheck in both) and persisted in three cats (at intake, alopecia/pruritus was absent in two and localized in one of these three).

In total, 53 (91%) cats were adopted, and five (8.6%) cats were euthanized for serious surgical complications ($n = 3$), delayed-onset ME ($n = 1$) and failure to improve postoperatively, polyp regrowth and FIV-positive status ($n = 1$).

Outcome analysis

A statistically significant proportion of cats showed resolution of pruritus/alopecia ($P = 0.001$), moderate/severe NP signs ($P = 0.002$), moderate/severe OE ($P < 0.001$) and purulent aural discharge ($P = 0.002$) (Table 3). At recheck, postoperative Horner's syndrome had persisted in 26/41 (63%) affected cats ($P < 0.001$) and resolved in 11/41 (27%) cats. Data were not available for 4/41 (10%) cats. There was no significant change for inappetence or presence of OI.

OI before VBO was associated with a significantly greater risk for moderate/severe OE at recheck (OR 4.35; 95% CI 1.21–15.70; $P = 0.02$) (Table 4). Surgery performed

Table 2 Surgical complications after 88 ventral bulla osteotomies in 58 cats with otitis media-interna, transferred from an institutional boarding environment

Complication	Considered serious?	After first surgery (n = 58)	After second surgery (n = 30)
None		18 (31)	11 (37)
Any complication		40 (69)	19 (63)
Serious complication		17 (29)	10 (33)
Life-threatening perioperative complications			
Cardiac arrest	Y	3 (5.2)	0
Dyspnea/upper airway obstruction – no tracheostomy/ventilation	Y	2 (3.4)	1 (3.3)
Dyspnea/upper airway obstruction – tracheostomy/ventilation	Y	1 (1.7)	0
Severe hemorrhage	Y	0	0
Early postoperative complications (within 2 weeks)*			
Acute wound infection	N	1 (1.7)	0
Aspiration pneumonia	Y	2 (3.4)	0
Congestion/cough/wheeze	Y	2 (3.4)	1 (3.3)
Nystagmus	N	1 (1.7)	1 (3.3)
Horner's syndrome	N	35 (60)	17 (57)
Otitis interna	Y	5 (8.6)	3 (10)
Head tilt/excursions		4 (6.9)	3 (10)
Ataxia		4 (6.9)	3 (10)
Meningoencephalitis [†]	Y	1 [‡] (1.7)	0
Prolonged complications (persisted >2 weeks postoperatively [§])			
Alopecia/pruritus*	Y	6 (10)	3 (10)
Chronic wound infection	Y	0	0
New anorexia (>1 week duration)	Y	2 (3.4)	4 (13)
Xerostomia, 'brown tongue'	Y	0	3 (10)
Number of complications		65	36
Number of serious complications		34	22

Data are n (%)

*New or markedly worse

[†]An additional cat developed presumed meningoencephalitis 2 months postoperatively (see text)

[‡]Based on a retrospective case review, was likely to have been present before surgery

[§]Other than new anorexia

by a generalist was also associated with higher risk for moderate/severe OE (OR 3.64; 95% CI 1.03–12.87; $P = 0.045$). No other associations with negative outcomes were identified (Tables 4 and 5).

Discussion

These results indicate that the risks of VBO in chronic OMI cannot confidently be balanced by an assurance that clinical problems will resolve after surgery. A significant proportion of cats showed resolution of NP signs, OE, purulent aural discharge and pruritus/alopecia, demonstrating clinical benefit. However, clinical signs did not resolve in a sizeable minority of cats. This might have been owing to chronic turbinate damage in some cats, as well as irreversible changes in the external, middle and inner ear.

Our analysis did not identify viable predictors of complications or negative outcomes. The association of OI with persistent OE, but not other outcomes, is of limited

value. Although generalists had worse outcomes for persistent OE compared with specialists, outcomes for other variables were similar. This suggests that this surgery can be successfully performed by a skilled generalist.

Feline OM may be underdiagnosed.¹⁷ The most obvious signs are head tilt and polyps, which were absent in more than half of the cats in our study. It was striking that most cats showed no inappetence at presentation, despite clinical rhinitis. This contrasts with the typical presentation of acute URI, in which lethargy and inappetence are common.²⁴ OMI should be considered a differential in cats with rhinitis and normal appetite, particularly if there is little response to an appropriate first-line antibiotic.

OE is generally uncommon in cats compared with dogs,^{25–27} but was common in cats with OMI in our study and others.¹³ OE is likely to be secondary to OMI in cats, while the opposite is the case in dogs.¹ While few cats were tested for ear mites because of routine use of selamectin, only 3/7 were positive. Dark, crumbly

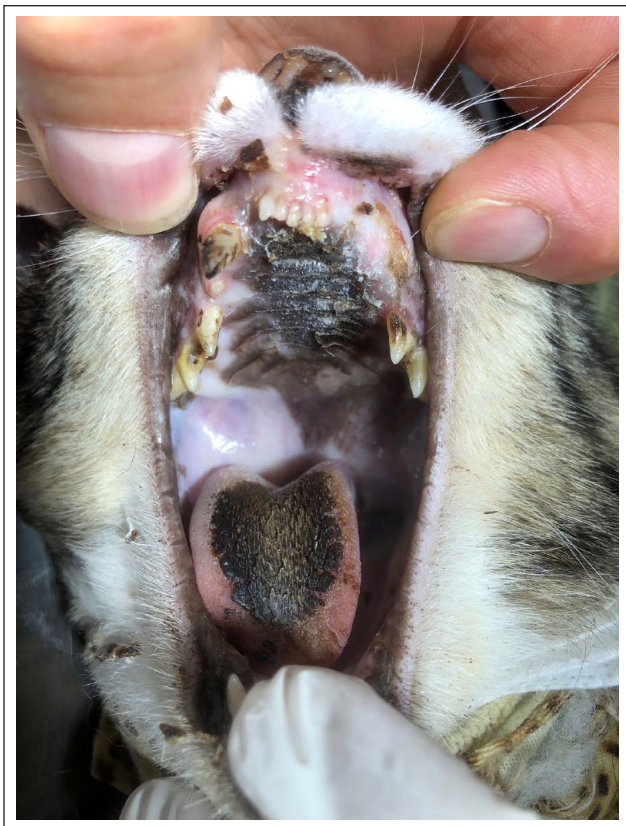


Figure 2 Xerostomia and brown discoloration of the tongue, gingiva and mucosa overlying the hard palate after ventral bulla osteotomy in a cat. Note the dry appearance of the oral cavity

exudate 'typical' for ear mites can be a presenting sign of OM.¹ Routine in-house microscopy should be performed on all cats presenting with OE. Negative results should increase suspicion of OMI.

Cytology and culture of myringotomy samples are useful diagnostic tools in middle-ear disease, but the primary diagnosis of otitis media is based on otoscopic examination and imaging.^{2,28} Confirmation in our study relied heavily on radiographs. This may have biased case selection toward more severe cases. Radiography has lower sensitivity for diagnosis of OM compared with CT or MRI,²⁹⁻³³ but radiographic diagnosis is feasible in chronic cases, in which changes can be striking (Figure 1). Bulla wall thickening is the most readily identifiable change. In our study, a scoring system using wall thickness, asymmetry and tympanic cavity opacity (data not shown) did not offer advantages over scoring bulla wall thickening alone. Correct positioning and interpretation of bulla radiographs are essential and require appropriate training.

Prolonged anorexia occurred after six surgeries and was associated with xerostomia and brown discoloration of the tongue in three cats that had bilateral VBOs. The most likely mechanism is hyposalivation and altered taste sensation through iatrogenic damage to the chorda tympani nerve.³⁴ Bilateral nerve damage would explain the occurrence of xerostomia only after the second surgery, as unilateral nerve function would presumably have been adequate after a single surgery. People report loss of taste, loss of taste acuity, or an unusual or bitter

Table 3 Resolution of clinical abnormalities at the veterinary recheck approximately 4 weeks after the final VBO, in 58 cats with otitis media-interna, transferred from an institutional boarding environment

	Before VBO	Recheck after VBO		P value	n
		Absent	Present		
Inappetence	Absent	46 (81)	4 (7.0)	0.50	57
	Present	6 (11)	3 (5.3)		
Pruritus/alopecia	Absent	24 (43)	3 (5.4)	0.001	56
	Present	19 (34)	10 (18)		
Moderate/severe nasopharyngeal signs	Absent	29 (53)	2 (3.6)	0.002	55
	Present	16 (29)	8 (15)		
Moderate/severe otitis externa	Absent	9 (16)	2 (3.6)	< 0.001	55
	Present	32 (58)	12 (22)		
Purulent aural discharge	Absent	33 (60)	2 (3.6)	0.002	55
	Present	16 (29)	4 (7.3)		
Horner's syndrome	Absent	26 (49)	26 (49)	< 0.001	53
	Present	1 (1.9)	0		
Otitis interna	Absent	27 (50)	4 (7.4)	1.00	54
	Present	5 (9.3)	18 (33)		
Head tilt/excursions	Absent	30 (54)	4 (7.1)	1.00	56
	Present	3 (5.4)	19 (34)		
Ataxia	Absent	52 (93)	3 (5.4)	Discordant cells too small	56
	Present	1 (1.8)	0		

Data are n (%). Data in cells shaded green (Present-Absent) and yellow (Absent-Present) were used in the McNemar test. Statistically significant P values are shown in bold type.

Green = resolved after VBO; orange (Present-Present) = did not resolve; VBO = ventral bulla osteotomy; yellow = developed after VBO

Table 4 OR* risk analysis for key negative outcomes, approximately 4 weeks after final VBO, in 58 cats with otitis media-interna, transferred from an institutional boarding environment

	Moderate/severe nasopharyngeal signs at recheck			Moderate/severe otitis externa at recheck			Clinical signs of otitis interna at recheck					
	n	OR	95% CI	P value	n	OR	95% CI	P value	n	OR	95% CI	P value
Preoperative variables												
FIV-positive	55	2.75	0.67–11.2	0.16	55	2.05	0.58–7.24	0.27	54	0.49	0.14–1.67	0.25
Moderate/severe nasopharyngeal signs	–	–	–	–	55	1.41	0.42–4.77	0.58	53	0.54	0.18–1.64	0.27
Moderate/severe otitis externa	55	0.50	0.11–2.39	0.39	–	–	–	–	54	0.78	0.11–2.98	0.72
Purulent aural discharge	55	0.71	0.16–3.10	0.64	55	2.15	0.63–7.42	0.22	54	0.29	0.08–1.04	0.06
Ruptured tympanic membrane	33	0.18	0.02–1.71	0.14	33	1.60	0.33–7.65	0.56	32	2.10	0.49–9.00	0.32
Polyp	55	0.86	0.19–3.79	0.84	55	0.47	0.11–1.97	0.30	54	2.50	0.78–7.97	0.12
Moderate/severe bulla wall thickening	51	0.77	0.19–3.15	0.72	51	1.31	0.38–4.50	0.67	50	0.38	0.11–1.24	0.12
Otitis interna	55	0.64	0.15–2.82	0.56	55	4.35	1.21–15.70	0.02	–	–	–	–
SEZ cultured	47	1.80	0.39–8.27	0.45	47	2.67	0.61–11.70	0.19	46	1.08	0.33–3.56	0.90
Surgical variables												
Two VBO surgeries	55	10.29	1.20–88.07	0.07	55	0.86	0.26–2.91	0.81	54	1.06	0.36–3.15	0.92
Generalist surgeon	55	3.69	0.89–15.27	0.07	55	3.64	1.03–12.87	0.045	54	1.77	0.56–5.57	0.44

*Odds ratios reflect risk of the outcomes listed compared with absence of these outcomes. Values in bold are statistically significant. CI = confidence interval; OR = odds ratio; FIV = feline immunodeficiency virus; SEZ = *Streptococcus equi* subspecies *zooepidemicus*; VBO = ventral bulla osteotomy

Table 5 OR* risk analysis for serious complications and euthanasia after VBO in cats with otitis media-interna, transferred from an institutional hoarding environment

	Serious complications				Euthanasia			
	n	OR	95% CI	P value	n	OR	95% CI	P value
Preoperative variables								
FIV-positive	58	0.75	0.23–6.80	0.63	58	1.54	0.23–10.13	0.65
Nasopharyngeal disease	57	2.77	0.92–8.32	0.07	57	0.84	0.13–5.46	0.86
Otitis externa	58	2.11	0.50–8.84	0.31	58	1.05	0.11–10.34	0.97
Purulent aural discharge	58	1.38	0.46–4.15	0.56	58	2.92	0.45–19.06	0.26
Ruptured tympanic membrane	35	1.09	0.27–4.50	0.90	35	0.53	0.05–5.68	0.60
Polyp	58	0.83	0.27–2.55	0.74	58	3.18	0.48–20.81	0.23
Moderate/severe bulla wall thickening	54	0.67	0.22–2.04	0.48	54	0.75	0.12–4.91	0.77
Otitis interna	58	0.42	0.13–1.32	0.14	58	0.35	0.04–3.37	0.37
SEZ cultured	48	3.40	0.97–11.98	0.06	–	–	–	–
Surgical variables								
Two VBO surgeries	58	2.19	0.74–6.50	0.16	58	0.60	0.09–3.86	0.59
Generalist surgeon	58	0.83	0.27–2.55	0.74	58	1.30	0.20–8.47	0.79

*Odds ratios reflect risk of serious complications or euthanasia, compared with their absence

CI = confidence interval; OR = odds ratio; FIV = feline immunodeficiency virus; SEZ = *Streptococcus equi* subspecies *zooepidemicus*; VBO = ventral bulla osteotomy

taste after chorda tympani damage,³⁴ and this might have contributed to anorexia after the first VBO in two cats. Dysbiosis secondary to xerostomia and antibiotics was suspected to have caused yeast overgrowth and brown discoloration of the tongue in three cats.

Although stress, allergic skin disease or parasites might have caused pruritus/alopecia, generalized pruritus was observed in this group of cats to a greater extent than is typically seen in this shelter and occurred in the face of broad-spectrum parasiticide products. Local discomfort probably caused pruritus in some cats, while generalized pruritus may have been owing to undiagnosed allergic skin disease in others. In OMI cases with persistent and generalized pruritus, feline hyperesthesia syndrome could be considered if an allergy work-up is negative. This has been reported in a cat with OMI and ME.³⁵

The decision to proceed with surgical management was typically based on a lack of response to medical management, as well as the assumption that moderate/severe bulla wall thickening would not respond adequately to medical treatment. This assumption remains untested. Additional reasons for pursuing surgery were previous experience with chronic OMI and concern for progression to ME. ME was rare in our study, and occurred as a postoperative complication, suggesting that surgery is not always protective. In the shelter setting, barriers to adoption, adopter expectations and future financial burden are also key considerations. However, given that VBOs did not always result in substantial clinical improvement, the prevalence of serious surgical complications is concerning.

Life-threatening perioperative complications, as also reported elsewhere,^{19,21,22} indicate that particular attention must be paid to anesthetic and postoperative airway management. Preoperative dexamethasone may reduce airway swelling,²² and is advisable in the absence of contraindications. Staging of bilateral VBOs appears to be safer for severe and chronic OMI, but substantially adds to the cost and duration of treatment.

OI did not resolve in most cats. Improvement was noted at some postoperative rechecks, but the data were not uniform enough to allow analysis. In previous reports, neurological improvement was reported in three-quarters of cats treated medically and all cats treated surgically,¹⁸ but OI did not fully resolve in any cat.¹⁶ Postoperative OI occurred in eight cats. This complication has been reported previously,^{16,17,19} and results from damage to sensitive structures and, possibly, extension of infection after surgical manipulation. More conservative osteotomy could be considered, but in the authors' experience (CP, PR), this may be insufficient and require revision, as occurred in three early cases in this series.

Concurrent FIV-positive status was not a negative prognostic indicator. This is important, because both FIV and OMI prevalences are high in some groups of hoarded cats.¹⁰ Bilateral disease requiring bilateral VBO was expected to be associated with worse outcomes, but this was not the case. Clinical SEZ infection in cats is associated with animal hoarding and can cause chronic upper and lower respiratory tract infection, OMI and ME.^{8,35–37} Surprisingly, a positive SEZ culture had no significant association with negative outcomes. This suggests that inflammatory changes, dysbiosis³⁸ and

chronicity may play a greater role than the specific organism identified.

Middle-ear infection is, in effect, an abscess in an inaccessible site, and this limits the value of systemic medications. Therapeutic myringotomy, flushing and topical therapy have been recommended.^{1,2,26} Despite cautions to the contrary,³ myringotomy may be feasible without specialized equipment, but requires skill and can result in complications. There is no primary peer-reviewed literature to support the effectiveness of therapeutic myringotomy and flushing in chronic feline OMI. Inflammatory tissue, chronic infection and the bony septum that greatly restricts access to the medioventral compartment of the feline tympanic cavity are likely to reduce the effectiveness of flushing and topical medication in chronic cases. Even if effective, multiple treatments might be required. Myringotomy was not attempted in our setting, primarily because of lack of confidence that these cases could be successfully treated in this way. In a recent study, medical management with a single myringotomy and flush, glucocorticoids and antibiotics was successful in 17/24 cats with OM.³⁹ However, severity, chronicity and criteria for success were not addressed in this preliminary report.

Could chronic medical management be reasonable in chronic OMI? Cats in our study typically had no obvious evidence of discomfort. Cats with OI were generally mobile and active, with disabling ataxia or head tilt being uncommon. It might be feasible to manage such cases conservatively, with treatment goals of avoiding progression and managing problematic NP signs and OE. One motivation for surgical management of OMI is the risk of extension of infection to the brainstem. Although ME was common in an older case series,⁴⁰ it is no longer a frequently reported complication,^{35,41} and may be amenable to medical treatment.^{35,41,42} Chronic rhinosinusitis (RSS) can be managed medically,⁴³ and this could form a blueprint for chronic OMI. Surgical management could be reserved for cases with quality-of-life concerns that might reasonably be expected to be alleviated by surgery.

This study was limited by its retrospective nature and the extraordinary difficulties of managing complex individual cases within a large group setting. The extent of improvement of ataxia and head tilt was not codified, and these would have been useful data. The assessment of the clinical success of VBO was limited by perpetuating factors for OE in a few cats and presumed, or CT-confirmed, RSS in a greater number. This reflects the reality that chronic RSS is part of the feline chronic upper respiratory disease complex.

Studies directly comparing different treatment approaches to chronic feline OMI would be of immense value. Groups of hoarded cats with OMI would present

an ideal opportunity to compare medical and surgical approaches to OMI, with potentially lifesaving, resource-sparing results. However, such studies would be complex and expensive.

Conclusions

The surgical management of chronic OMI was successful in many cases, but it was not benign, and not always beneficial. The improvement of signs of OI is a reasonable treatment goal, while full resolution is less likely. Serious complications, including some that were life-threatening and others that compromised welfare and were highly resource-intensive, were quite frequent. No viable predictors of surgical and overall outcomes could be identified. Conservative medical management of OMI could be considered, with surgery reserved for cases in which there are quality of life concerns that might reasonably be expected to be ameliorated by VBO.

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Supplementary material The following files are available as supplementary material:

File 1: Examination template for cats following ventral bulla osteotomy,



File 2: Classification of clinical features of otitis media-interna, and dichotomous groupings used for statistical analysis.

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Ethical approval The work described in this manuscript involved the use of non-experimental (owned or unowned) animals. Established internationally recognized high standards ('best practice') of veterinary clinical care for the individual patient were always followed and/or this work included the use of cadavers. Ethical approval from a committee was therefore not specifically required for publication in *JFMS*. Although not required, where ethical approval was still obtained, it is stated in the manuscript.

Informed consent Informed consent (verbal or written) was obtained from the owner or legal custodian of all animal(s) described in this work (experimental or non-experimental animals, including cadavers) for all procedure(s) undertaken (prospective or retrospective studies). No animals or people are identifiable within this publication, and therefore additional informed consent for publication was not required.

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