

Surgical creation of multiple drainage holes versus local injection of corticosteroids for treatment of aural hematomas in dogs: 51 dogs with 71 aural hematomas (2000–2017)

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OBJECTIVE

To investigate the outcome of surgical creation of multiple drainage holes (MDHs) versus local corticosteroid injection (LCI) for treatment of aural hematomas (AHs) in dogs and identify risk factors for recurrence and development of new AHs.

ANIMALS

51 dogs with 71 AHs.

PROCEDURES

Medical records were reviewed, and information on signalment, clinical findings, and outcome was recorded. Recurrence was defined as development of an AH at the primary site after the first month of treatment. Development of a new AH was defined as an AH occurring at a site different from the treated site.

RESULTS

The recurrence rate after the first month of treatment was significantly higher following the LCI procedure (17/48 AHs [33%]) than after the MDH procedure (1/24 AHs [4%]). The odds of recurrence increased as the numbers of LCI in the first month increased (OR, 2.414). Recurrent AHs after LCI resolved with additional LCIs; only 1 AH (2%) required a change to MDHs. No recurrence was observed after the eighth month, and the cosmetic results were good. Sixteen of 51 (31%) dogs had multiple or new AHs. The risk of new AHs was higher in Golden Retrievers and Labrador Retrievers and in dogs with allergic dermatitis.

CONCLUSIONS AND CLINICAL RELEVANCE

Long-term outcomes suggested that both creation of MDHs and LCI can be therapeutic options for dogs with AHs. However, the risk of new AH development should be considered, especially in retriever breeds and dogs with allergic dermatitis.

In dogs, aural hematomas (AHs) represent accumulations of hemorrhagic fluid within the layers of the pinna.¹⁻³ The exact source of this hemorrhagic fluid is unknown; however, intraoperative⁴⁻⁷ and histologic^{4-6,8,9} observations have shown that most AHs in dogs exist within fractures and lacerations of the auricular cartilage. Ear scratching and head shaking secondary to otitis externa are thought to be the main causes of cartilage disruption, with cartilage disruption leading to rupture of blood vessels in the auricular cartilage and subsequent AH formation.^{1,6,8,10}

Because 24% to 64% of dogs with AHs reportedly have no concurrent otitis externa,^{9,11-14} factors other than mechanical trauma are likely also involved. Kuwahara⁴ postulated, on the basis of results of serologic and immunologic investigations, that cartilage degeneration secondary to an autoimmune reaction was the primary cause of AHs. A later study¹³ did not support the autoimmune pathogenesis but suggested a role for immunologic factors in cartilage

degeneration or healing reactions associated with AHs. Because the fluid within an AH is actually a seroma rather than a hematoma,^{4,5,13} the inflammatory response, which might be either the cause or a result of cartilage disruption, may contribute to production of AH fluid. This is supported by the therapeutic effect of local corticosteroid injection (LCI) for treatment of AHs.^{15,16}

The disrupted auricular cartilage associated with an AH heals through adhesions resulting from formation of granulation tissue, rather than through cartilage regeneration.^{6,8} Healing is delayed by fluid accumulation in the cavity, and patients with untreated AHs develop persistent discomfort and, eventually, deformity of the pinna.^{4,8} Several drainage techniques have been successfully used to facilitate early healing, including placement of a silicone rubber drain^{12,17} or teat cannula,¹⁴ closed-suction drainage,^{5,7,18} creation of a longitudinal or S-shaped incision,^{1,10,19} and creation of multiple drainage holes (MDHs).^{3,11,20,21}

These techniques are usually performed in conjunction with procedures intended to decrease the size of the AH cavity, such as application of compression bandages,^{1,10,18-21} placement of mattress sutures or stents in the pinna,^{1,10,19-22} ablation of the cavity with a carbon dioxide laser,¹¹ or placement of continuous sutures between the cavity's walls.²³ Reported recurrence rates after these surgeries are low (0% to 27%).^{5,7,11,12,17,18,20,21,23}

In a recent survey²² of veterinary practitioners in the United Kingdom, LCI was the most frequently used first-line treatment for AHs. Although LCI is technically easy, inexpensive, and minimally invasive, that study showed that veterinarians who chose LCI were more concerned about recurrence than were those who chose surgery. Some authors do not recommend LCI because of concerns that it may delay the healing process,^{24,25} but there is little information regarding recurrence rates after LCI. Although the success rate following surgical treatment of AHs in dogs is high, the cost and invasiveness of surgical treatment may be problematic, especially in dogs requiring multiple surgeries for multiple AHs. However, there is little information on the incidence of or risk factors for development of new AHs.

The primary objective of the study reported was to evaluate short- and long-term outcomes of surgical creation of MDHs versus LCI for treatment of AHs in dogs, including rates of recurrence at the affected site and development of new AHs. The secondary objective was to investigate risk factors for recurrence and development of new AHs. We hypothesized that the incidence of recurrence would be higher after LCI than after creation of MDHs and that development of new AHs would not be uncommon during long-term follow-up of dogs with AHs.

Materials and Methods

Case selection

Medical records of the Aoba Animal Hospital were searched to identify dogs treated for AHs between January 2000 and December 2017. Dogs were eligible for inclusion in the study if information was available on location of the AH, the medical record included a detailed description of the treatment provided, and follow-up information for at least 12 months after treatment was recorded. In accordance with the treatment policy of the hospital, first-line treatment for AHs consisted of surgical creation of MDHs up to June 2005 and LCI thereafter. Information for some dogs treated with MDHs has been reported previously²¹; additional follow-up information was obtained for these dogs before their inclusion in the present study.

For dogs included in the study, the following information was collected: breed, sex, age, body weight, location of the AH, volume and properties of the AH fluid, presence or absence of concurrent otitis externa, presence of other comorbid conditions,

treatment, location of recurrence and its treatment, final appearance of the pinna, and follow-up time.

MDH procedure

A previously reported²⁰ technique for surgical creation of MDHs was performed as the initial treatment or as the secondary treatment after recurrence following another treatment. With the dog under general anesthesia, both the convex and concave surfaces of the affected pinna were shaved and disinfected to prepare the operative field. A 6- or 8-mm-diameter skin biopsy punch (disposable biopsy punch; Kai Europe GmbH) was then used to create multiple holes into the AH cavity on the concave side of the pinna. The distance between the holes was wider than the diameter of the holes. If fibrous tissue was present in the AH cavity, it was removed by inserting a mosquito forceps in one of the holes. Between each punch hole, a mattress suture oriented in the longitudinal direction of the pinna was placed through all layers of the pinna with 2-0 or 3-0 nylon. After the operation, a bandage was placed either with the pinna turned over on top of the head (for dogs with pendulous ears) or with the concave surface of the treated ear covered with a cylindrical roll of gauze. An Elizabethan collar was then placed. The gauze was changed every 2 to 3 days, and the bandage was removed after 5 to 7 days. After bandage removal, prednisolone (0.2 to 1.0 mg/kg/d) was prescribed for most dogs, and topical treatment was started for dogs with otitis externa. Antimicrobials were prescribed until suture removal.

LCI procedure

All LCIs were performed without sedation or anesthesia and with the use of an Elizabethan collar to pull the affected ear away from the head, as needed. After the concave surface of the pinna was disinfected, the AH contents were aspirated with a 23- or 25-gauge needle or a 23-gauge butterfly needle connected to a 2- to 10-mL syringe, depending on the size of the AH. The syringe was then removed, and 0.5 to 2.0 mg (0.05 to 0.20 mL) of triamcinolone acetonide (Kenacort-A intradermal-intraarticular; Bristol-Myers Squibb Co) was injected into the cavity through the same needle. The dose of triamcinolone was determined on the basis of the size of the AH. Two milligrams of triamcinolone was used for large AHs (eg, AHs involving more than a third of the area of the pinna in medium- to large-sized dogs or more than half the area of the pinna in small-sized dogs), and 0.5 to 1 mg of triamcinolone was used for smaller AHs in any dog. No more than 1 mg of triamcinolone was used in toy-breed dogs, regardless of how much of the pinna was affected. A bandage was not applied, and treatment with prednisolone (0.1 to 1.3 mg/kg/d, PO), initially, followed by gradual tapering of the dosage) was prescribed in most cases. Topical treatment was immediately started for dogs with otitis externa. The owner was instructed to return the patient to

the hospital 2 to 3 days later, and LCIs were repeated at least every 2 to 3 days as necessary until effusion was no longer present, with lower doses of triamcinolone used for smaller volumes of re-accumulation. The same LCI protocol was used in cases of AH recurrence.

Evaluation of AH fluid

The volume, Hct, and total protein concentration of fluid aspirated from dogs undergoing LCI were measured.

Assessment of recurrence

Because most dogs treated with MDHs underwent suture removal approximately 3 weeks postoperatively and at least some dogs treated by LCI underwent repeated injections for 3 to 4 weeks, recurrence was defined as development of an AH at the primary site after the first month of treatment. Development of a new AH was defined as an AH occurring at a site different from the treated site. Recurrence was differentiated from development of a new ipsilateral AH by examining illustrations in the medical record and, in dogs treated with MDHs initially, by inspection of and palpation for surgical scars.

Statistical analysis

Descriptive data (mean, SD, median, range, and percentages) were calculated. The Shapiro-Wilk test was used to determine whether continuous variables were normally distributed. Normally distributed data are reported as mean \pm SD; data that were not normally distributed are reported as median (range). Breed (Golden Retriever or Labrador Retriever vs all other breeds), sex, neutering status, age at onset, concurrent otitis externa, allergic dermatitis requiring long-term treatment, other concurrent diseases, and follow-up time were assessed for their association with development of a new AH. These variables (with the exception of follow-up time), data regarding the AH fluid, and treatment of the AH were also assessed for an association with recurrence after the first month. The time during which the AH was present before treatment was not assessed because information was not available for a sufficient number of cases. For categorical variables, the χ^2 test or Fisher exact test (when the expected value for any cell was ≤ 5) was used. For continuous variables, logistic regression analysis was performed. Variables with a value of $P < 0.2$ were considered for inclusion in multivariable analyses. However, if a strong correlation was detected between variables with a Pearson correlation coefficient (r) > 0.80 , only the variable with the higher OR was entered to avoid multicollinearity. Logistic regression with backward elimination, retaining variables with a value of $P < 0.1$, was used for the multivariable analysis. The fit of the final multivariable model was assessed with the Hosmer-Lemeshow test.²⁶ Differences in recurrence rates after the MDH and LCI procedures and differences in

signalment between the 2 treatment groups (breed, sex, neutering status, age at onset, concurrent otitis externa, and concurrent allergic dermatitis) were assessed by means of univariable analysis as described for other data. All statistical analyses were performed with standard statistical software (Dr. SPSS II for Windows, Nankodo Co). For all analyses, values of $P < 0.05$ were considered significant.

Results

A total of 76 dogs were treated for AHs during the study period. However, 19 dogs (MDHs, $n = 3$; LCI, 16) were excluded because of a lack of follow-up (9) or insufficient follow-up (10). The remaining 51 dogs were included in the study. These 51 dogs had 75 AHs, but 4 AHs that developed after initial treatment of an AH were excluded because of insufficient follow-up ($n = 3$) or a lack of treatment (1 chronic AH). As a result, outcomes for 71 AHs were evaluated.

The 51 dogs included in the study consisted of 15 Golden Retrievers, 7 Labrador Retrievers, 7 mixed-breed dogs (4 with erect ears), 4 Miniature Schnauzers, 4 French Bulldogs, 3 Shih Tzus, 2 English Bulldogs, 2 Beagles, 2 Miniature Dachshunds, 1 Maltese, 1 Tibetan Terrier, 1 Cairn Terrier, 1 Shiba Inu, and 1 Dalmatian. Of the 51 dogs, 41 (80%) had pendulous ears. Body weight ranged from 4 to 48 kg (median, 18.4 kg); 11 (22%) dogs weighed < 10 kg. Twenty-seven dogs were females (9 spayed), and 24 were males (3 castrated). Excluding 1 dog of unknown age, mean \pm SD age at the onset of the AH was 9.2 ± 2.9 years. Most dogs were middle-aged to older dogs; for 62 of 70 (89%) AHs, dogs were > 5 years old at the age of onset (**Figure 1**).

Sixteen (31%) dogs developed new AHs after the initial treatment; 8 of these had undergone the MDH procedure and the other 8 had undergone the LCI procedure as treatment for the first AH. Ten dogs developed 2 AHs (1 AH on each side), 4 dogs developed 3 AHs (2 AHs on one side and 1 AH on the other side), and 2 dogs developed 4 AHs (2 AHs on each side). Time from treatment of the initial AH

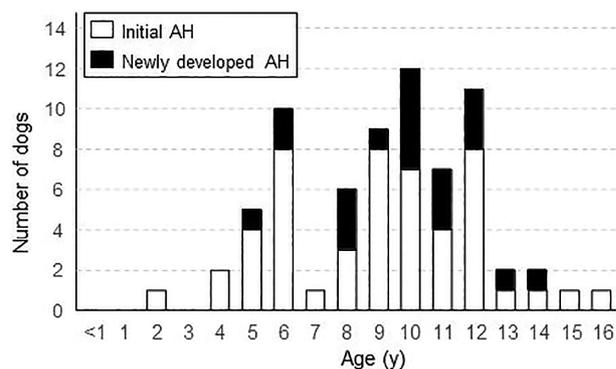


Figure 1—Age distribution at onset for 70 aural hematomas (AHs) in 50 dogs.

to development of new AHs ranged from 0 days (ie, simultaneous bilateral AHs) to 1,937 days (median, 435 days) for all 24 new AHs and ranged from 82 to 1,937 days (median, 873 days) for the 8 new AHs that occurred ipsilaterally (6 of these 8 had initially been treated with the MDH procedure). Of the 24 AHs, 4 were excluded from the study as described previously.

Of the 71 AHs (34 on the right, 37 on the left), 46 (65%) were associated with otitis externa in the ipsilateral ear at the time of AH treatment. Five of 51 (10%) dogs (8 AHs) had allergic dermatitis requiring drug treatment for several years; 3 of these dogs had atopic dermatitis, and 2 had middle-aged-onset allergic dermatitis associated with food substances (n = 1) or an undetermined cause (1). Other concurrent diseases included pyoderma (3 AHs in 3 dogs), scabies (3 AHs in 2 dogs), and infestation with engorged ixodid ticks (1 AH in 1 dog). No dogs had a history of ear mite infestation, immune-mediated diseases other than allergy, or notable systemic diseases.

Outcome of the MDH procedure

Twenty-four AHs in 18 dogs were treated with the MDH procedure (Table 1). This was the initial treatment for 22 AHs in 16 dogs, the second treatment after failure of LCI in 1 AH in 1 dog, and the second treatment of 1 AH in 1 dog that relapsed 32 days after treatment by means of a longitudinal incision with cartilage sutures. Duration of the AH before surgery was recorded for 13 AHs and ranged from 1 to 7 days (median, 1 day).

In all instances, cartilage attached to the skin on the concave aspect of the pinna was excised to create the drainage holes, indicating that the cavity of the AH was located within the cartilage. The number of holes created for each AH ranged from 2 to 29 (median, 8), and the number of mattress sutures placed ranged from 3 to 22 (median, 9.5). At the time of bandage removal 5 to 7 days postoperatively, the

holes were almost closed through second-intention healing. Concurrent otitis externa had improved with topical treatment by the time of suture removal in most cases. Prednisolone was prescribed following treatment of 21 AHs and was administered for 2 to 54 days (median, 10 days). The mattress sutures were removed 10 to 27 days (median, 16 days) postoperatively for 21 AHs in 15 dogs and 41 to 240 days postoperatively for 3 AHs in 3 dogs.

Two dogs developed partial AHs at the treated sites 15 days postoperatively (at the time of suture removal) and 19 days postoperatively (4 days after suture removal), and both AHs resolved after creation of additional drainage holes. Recurrence of an AH at the periphery of the operative site was observed in 1 dog 53 days postoperatively (at the time of suture removal), and this AH resolved with creation of an additional drainage hole and placement of an additional suture. After the second month, no dogs developed a recurrence at the operative site during follow-up times ranging from 18 to 72 months (median, 54 months). Cosmetic changes were minimal (slight irregularity on palpation) in all instances, except that 1 pendulous-eared dog had a markedly thickened pinna that underwent suture removal 240 days postoperatively.

Outcome of the LCI procedure

Forty-eight AHs in 39 dogs were treated with the LCI procedure. Duration of the AH before the LCI procedure was recorded for 34 AHs and ranged from 1 to 14 days (median, 2 days).

For the AHs treated with the LCI procedure, 1 to 5 injections (median, 2 injections) were performed between 1 and 24 days (median, 5 days) after the first visit. The dose of triamcinolone used for the first LCI was 0.5 to 2.0 mg (median, 2.0 mg), with 44 of 46 AHs treated with 1 to 2 mg of triamcinolone. The interval between the first and second injections was

Table 1—Clinical data and treatment outcome for 71 aural hematomas (AHs) in 51 dogs treated by means of surgical creation of multiple drainage holes (MDHs) or local corticosteroid injection (LCI).

Variable	MDH creation		LCI		P value ^c
	Dogs (n = 18) ^a	AHs (n = 24) ^b	Dogs (n = 39) ^a	AHs (n = 48) ^b	
Retriever breed	11 (61)	16 (67)	15 (38)	19 (40)	0.045
Male	9 (50)	14 (58)	17 (44)	20 (42)	0.139
Neutered	2 (11)	2 (8)	10 (26)	14 (29)	0.07
Concurrent otitis externa	14 (78)	18 (75)	24 (62)	30 (63)	0.427
Allergic dermatitis	1 (6)	1 (4)	4 (10)	8 (17)	0.131
Age (y)	8.3 ± 2.3	8.5 ± 2.5	9.5 ± 3.1	9.5 ± 3.0	0.162
Body weight (kg)	27.5 (6.7–32.0)	28.5 (6.7–32.0)	15 (4.0–48)	15 (4.0–48)	0.039
Recurred					
Second month	1 (6)	1 (4)	12 (31)	13 (27)	
Third month	0 (0)	0 (0)	6 (15)	6 (35)	
Fourth to eighth month	0 (0)	0 (0)	3 (8)	4 (8)	
After eighth month	0 (0)	0 (0)	0 (0)	0 (0)	
Total	1 (6)	1 (4)	15 (36)	17 (33)	0.004

Data are given as number of dogs (%) or number of AHs (%), except that age is reported as mean ± SD and body weight is reported as median (range).

^aSix dogs that received both treatments are duplicated. ^bOne AH treated by LCI that was subsequently treated by creation of MDHs because of recurrence was duplicated. ^cP value for comparison of AHs between treatment groups.

Table 2—Results of univariable analyses for an association between variables of interest and recurrence after the first month for 48 AHs treated by means of LCI.

Variable	Recurrence		P value	OR (95% CI)
	Yes	No		
Retriever breed ^a	7 (41)	12 (39)	0.867	1.11 (0.33–3.70)
Male	8 (47)	12 (39)	0.575	1.41 (0.43–4.65)
Neutered	4 (24)	10 (32)	0.525	0.65 (0.17–2.49)
Concurrent otitis externa	9 (53)	21 (68)	0.311	0.54 (0.16–1.80)
Allergic dermatitis	3 (18)	5 (16)	1.000	1.11 (0.23–5.37)
Other concurrent diseases ^b	2 (12)	2 (6)	0.607	1.93 (0.25–15.12)
Age (y)	10.2 ± 2.4	9.1 ± 3.2 ^c	0.214	1.15 (0.93–1.42)
Body weight (kg)	22 (4.2–46.4)	12 (4–48)	0.217	1.03 (0.98–1.08)
VAHF (mL)	10 (2–50)	7 (0.5–30) ^d	0.086	1.05 (0.99–1.12)
MDTA (mg)	2 (1–2)	1 (0.5–2)	0.046	3.39 (1.02–11.24)
MDTA/VAHF (mg/mL)	0.15 (0.04–0.5)	0.17 (0.005–2) ^d	0.240	0.21 (0.02–2.85)
MDTA/body weight (mg/kg)	0.09 (0.04–0.24)	0.09 (0.02–0.25)	0.821	0.31 (0.76–6.21)
MDP/body weight (mg/kg)	0.67 (0–1.33)	0.5 (0–1.25)	0.632	1.43 (0.33–6.11)
Duration of prednisolone treatment (d)	7.5 ± 6.5	12.5 ± 8.1	0.035	1.10 (1.01–1.20)
No. of LCIs in first month	2 (1–5)	2 (1–4)	0.018	2.26 (1.15–4.44)

Categorical variables are reported as number (%) of AHs; continuous variables are reported as mean ± SD or median (range).

MDP = Maximum dose of prednisolone. MDTA = Maximum dose of triamcinolone acetonide. VAHF = Volume of AH fluid aspirated before the first LCI.

^aEach of the other breeds also had no significant association with recurrence. ^bIncluding pyoderma, scabies, and infestation with ixodid ticks.

^cOne case was excluded because of lack of data. ^dTwo cases were excluded because of lack of data.

2 to 9 days (median, 3 days), and the interval between the subsequent injections was 2 to 15 days (median, 4 days). Oral administration of prednisolone for a mean ± SD of 11.4 ± 6.8 days was used in conjunction with 39 AHs. Concurrent otitis externa resolved with topical treatment within a few weeks in most cases. The follow-up period after the first LCI was 12 to 124 months (median, 36 months).

Seventeen of 48 (35%) AHs in 15 of 39 (38%) dogs recurred between the second and eighth month (Table 1). One, 2, and 3 recurrences were reported for 11, 4, and 2 AHs, respectively. One (2%) AH that did not respond to LCI was treated with creation of MDHs after 2 months. The other recurrent AHs were treated with 1 or 2 LCIs and did not recur during follow-up times ranging from 7 to 65 months (median, 30 months) after the last injection. No cosmetic change was reported in any case.

Evaluation of AH fluid

Volume of the initial AHs treated with the LCI procedure ranged from 0.5 to 50 mL (median, 7 mL; n = 46), total protein concentration ranged from 2.2 to 6.8 g/dL (median, 4.2 g/dL; 28), and Hct ranged from 0.5% to 26% (median, 4.2%; 31). For 26 of 31 (84%) AHs, the Hct was < 10%.

Risk factors for recurrence

The recurrence rate after the first month of treatment was significantly ($P = 0.004$) higher following the LCI procedure (17/48 AHs [33%]) than after the MDH procedure (1/24 AHs [4%]; Table 1). Risk factors for recurrence were mainly evaluated for AHs treated with the LCI procedure, because only 1 AH recurred after the MDH procedure. Univariable analysis revealed that recurrence after LCI was significantly

associated with dose of triamcinolone used for the first LCI, duration of prednisolone administration, and number of LCIs during the first month (all P values < 0.05) and volume of the AH fluid at the initial treatment ($P = 0.086$; Table 2). Moderate correlations were found between the dose of triamcinolone and AH fluid volume ($r = 0.577$) and between the duration of prednisolone administration and number of LCIs ($r = 0.530$). The final multivariable model revealed that a higher likelihood of recurrence was significantly associated with increased numbers of LCIs ($P = 0.034$; OR, 2.41; 95% CI, 1.08 to 5.45) but was not significantly associated with a high dose of triamcinolone ($P = 0.080$; OR, 3.23; 95% CI, 0.87 to 12.02). Recurrence rates of AHs that received 1, 2, 3, or 4 to 5 LCIs in the first month were 14% (2/14), 38% (8/21), 38% (3/8), and 80% (4/5), respectively.

Because prednisolone was given to most dogs following the MDH procedure, the association between duration of prednisolone treatment and recurrence was also examined by including AHs treated with the MDH procedure. No significant association between the duration of prednisolone treatment and recurrence was found for AHs treated with the MDH procedure ($P = 0.951$) or for all AHs combined treated with the MDH or LCI procedure ($P = 0.207$).

Risk factors for development of new AHs

Eleven of 16 (69%) dogs that developed new AHs were Golden Retrievers (n = 8) or Labrador Retrievers (3); the other 5 dogs consisted of 2 mixed-breed dogs and 3 purebred dogs of 3 different breeds. Considering the small numbers of dogs of each breed, the 2 retriever breeds combined were compared with all other dogs. In univariable analyses, development of a

Table 3—Results of univariate analysis for association between variables of interest and development of new AHs in 51 dogs with AHs treated by means of MDH creation or LCI.

Variable	New AH developed		P value	OR (95% CI)
	Yes	No		
Retriever breed ^a	11 (69)	11 (31)	0.013	4.8 (1.34–17.19)
Male	7 (44)	17 (49)	0.749	0.82 (0.25–2.71)
Neutered	3 (19)	9 (26)	0.730	0.67 (0.15–2.89)
Concurrent otitis externa	13 (81)	20 (57)	0.095	3.25 (0.78–13.48)
Allergic dermatitis	4 (25)	1 (3)	0.029	11.33 (1.15–111.69)
Other concurrent diseases ^b	3 (19)	3 (9)	0.363	1.13 (0.87–1.45)
Age (y)	8.5 ± 2.5	9.2 ± 3.3 ^c	0.446	0.93 (0.76–1.13)
Body weight (kg)	26.5 (4.2–46.4)	14.9 (4–30.2)	0.065	1.05 (1.00–1.11)
Duration of follow-up (mo)	39.5 (15–75)	39 (12–124)	0.719	1.01 (0.98–1.03)

Categorical variables are reported as number (%) of dogs; continuous variables are reported as mean ± SD or median (range).

^aEach of the other breeds also had no significant association with recurrence. ^bIncluding pyoderma, scabies, and infestation with ixodid ticks. ^cOne dog was excluded because of unknown age.

new AH was significantly associated with the retriever breeds and allergic dermatitis ($P < 0.05$ for both) and with concomitant otitis externa ($P = 0.095$) and body weight ($P = 0.065$; **Table 3**). Because body weight was strongly correlated with retriever breeds ($r = 0.809$), the former was excluded from further analysis. The final multivariable model revealed that the 2 retriever breeds ($P = 0.011$; OR, 6.72; 95% CI, 1.55 to 29.14) and dogs with allergic dermatitis ($P = 0.021$; OR, 19.22; 95% CI, 1.56 to 236.89) were significantly associated with a high risk of developing new AHs.

Discussion

In the present study, the recurrence rate after the first month of treatment was significantly higher among dogs that underwent the LCI procedure (17/48 AHs [33%]) than among dogs that underwent the MDH procedure (1/24 AHs [4%]), and the data suggested that an increased number of LCIs in the first month was associated with subsequent recurrence. The long-term outcome was good following either treatment; however, 31% (16/51) of dogs had multiple AHs or developed new AHs, with a higher risk in Golden Retrievers and Labrador Retrievers and in dogs with allergic dermatitis.

Aural hematomas reportedly occur more commonly in medium- to large-breed dogs,^{4,9,12,13,23} pendulous-eared dogs (80% to 88%^{9,11,13}), and middle-aged to older dogs (> 4 years; 86% to 93%^{9,11–13}), and similar trends were observed in the present study. Golden Retrievers and Labrador Retrievers represented 43% (22/51) of the dogs in the present study, which was similar to percentages in some previous reports (32% to 67%^{9,11,13}); however, whether these breeds have a higher risk remains unknown because of a lack of comparison with the general dog population. Although some authors have reported that AHs are located between the skin and cartilage,^{2,19,25} all 24 AHs treated with the MDH procedure in the present study were located within the auricular cartilage, as observed in previous studies.^{4–9} This indicates that most AHs are associated with cleavage of the cartilage

plate. The predilection in middle-aged to older dogs suggests that cartilaginous changes associated with aging may be partly involved in the cartilage disruption that leads to AHs.⁹ The predilection in dogs with large, pendulous ears appears to support the theory that intracartilaginous sinusoidal waves caused by head shaking contribute to AH formation.⁸ In addition, AHs without concurrent otitis externa, as seen in the present study (25/71 AHs [35%]) and previous studies (24% to 64%^{9,11,14}), may support the hypothesis of causative factors other than trauma.⁴

The incidence of multiple or new AHs (16/51 dogs [31%]) was similar to that in a previous report (7/22 [32%]),¹² suggesting that development of new AHs is not uncommon in dogs with AHs. A previous study⁶ showed that dogs with a unilateral AH had histologic evidence of small cartilage ruptures in the clinically normal contralateral ear. Therefore, some patients with AHs may be predisposed to small cartilage ruptures at multiple sites in both ears. This may partly involve persistent or intermittent trauma to the ear,⁶ such as scratching. Although the number of dogs with concurrent diseases other than otitis externa was small in the present study, our results suggested that the risk of new AH development was increased by allergic dermatitis rather than concurrent otitis externa. Possible reasons for this include the fact that ear scratching due to allergy usually lasts longer than that due to transient otitis; it has also been hypothesized that local immunologic events caused by allergy may contribute to the degeneration of auricular cartilage, potentially leading to its disruption.¹³ Because allergic dermatitis is common, whereas AHs are quite rare in small-breed dogs, and because AHs have been suggested to have multifactorial causes,^{5,9} allergy is likely an additional causative factor not in all dogs but in those particular dogs with AHs. The higher risk in the 2 retriever breeds in the present study may reflect a breed-specific predisposition to AHs but may also be attributable to their wide pinna, where new AHs can develop. Further studies comparing other breeds that have similar large-sized ears are needed to clarify this issue.

In the present study, fluid analysis suggested that most AHs were seromas rather than hematomas, as has been previously reported.^{4,5,13} Previous histologic studies^{6,9,13} have revealed marked edema, dilatation of lymphatic vessels, and mild to moderate inflammation in the dermis around the AH cavity, and these surrounding abnormalities are thought to be the source of the AH fluid.^{5,6} Histologic studies^{8,9} have also suggested that the healing process in the cartilage is slower than that in other soft tissues, with only thin fibrous tissue on the cartilage surface even several days after AH onset.⁹ This may help explain why most drainage procedures require 2 to 3 weeks to achieve adhesion.^{3,5,7,12,14,16,17,20,21} On the basis of these previous findings, 3 therapeutic strategies for control of AHs in dogs have been suggested: control inflammation and edema (ie, inhibit the formation of new exudates), provide continuous drainage throughout the slow healing process, and promote the formation of adhesions.⁹ Theoretically, LCIs can reduce inflammation and edema¹⁶ but may slow the formation of adhesions,^{24,25} whereas creation of MDHs inevitably induces additional inflammation in the pinna but can achieve reliable drainage and early development of firm adhesions.⁹

Both the short- and long-term outcomes of MDHs were good with a low recurrence rate (1/24 AHs [4%]) and minimal cosmetic changes in the present study. One recurrence at the second postoperative month was likely due to an insufficient number of drainage holes near the AH margin. In 3 cases, including this case, creation of additional drainage holes led to resolution, as previously reported for 3 of 11 dogs that underwent MDH creation.²⁰ The punch holes were almost closed by second-intention healing within 1 week, also as previously reported.²⁰ Because early closure of the holes limits the drainage effect, concomitant mattress sutures appeared to be needed to prevent early fluid re-accumulation. Edematous thickening of the pinna was usually observed until suture removal, but this edema did not lead to persistent cosmetic changes with the exception of 1 case in which the sutures were left in place for 8 months. Prednisolone was prescribed in most cases to reduce postoperative inflammation of the pinna, as previously described for dogs treated by indwelling drainage¹²; however, the necessity of prednisolone in dogs undergoing MDH creation could not be addressed in the present study.

Considering the disadvantages of the MDH procedure (eg, anesthesia costs and invasiveness), we chose LCI as first line treatment in the later part of the study period. Past reports^{15,16} have indicated high success rates for treatment of AHs with LCIs (97% to 100%); however, 33% (17/48) of the AHs recurred after the first month in the present study. The exact reason for this discrepancy is unclear, but there are differences in the case compositions and treatment procedures among studies. Kuwahara¹⁶ reported that 67% (20/30) of dogs treated with dexamethasone IV

(with or without LCI) had an ear mite infestation as a possible trigger of an autoimmune reaction. Eradication of the ear mites may have terminated the immune response in those cases, whereas other predisposing factors may have persisted in the dogs in our study that developed a recurrence. In addition, Kuwahara¹⁶ performed lavage of the AH cavity before LCI and terminated the daily dexamethasone treatment within 1 week. Because dexamethasone has 6 times the potency of triamcinolone,²⁷ the efficacy of LCI in that study (0.2 to 0.4 mg of dexamethasone)¹⁶ was almost equivalent to that of LCI in the present study (1 to 2 mg of triamcinolone), but the dosage of dexamethasone (0.5 to 2 mg/kg/d, IV)¹⁶ was much higher than the standard immunosuppressive dosage (0.2 to 0.3 mg/kg/d).²⁸ The LCI protocol that we used was similar to that reported by Romatowski,¹⁵ in which 1 to 2 mg of triamcinolone was injected after aspiration of the AH fluid without irrigation, with prednisolone prescribed at an anti-inflammatory dosage (0.125 to 0.25 mg/kg/d) for 2 weeks, as in our cases (0 to 1.25 mg/kg/d; median, 0.5 mg/kg/d); however, no background information on the cases was provided in that report.

In the present study, risk factors for recurrence were evaluated mainly in dogs treated by LCI because only 1 AH recurred after MDH creation. We had expected that large AHs would be more likely to recur because of the insufficient effect of triamcinolone. In the univariable analysis, a high triamcinolone dose, which tended to be used for large AHs, was associated with a high risk of recurrence. In the multivariable analysis, however, a significant association was not detected between triamcinolone dose and recurrence, suggesting that an insufficient triamcinolone dose may not be a reason for recurrence. In the multivariable analysis, only the number of LCIs in the first month was associated with subsequent recurrence. This may be reasonable because the number of LCIs reflects the number of re-accumulations of fluid in the first month. However, the number of LCIs was also dependent on the owner returning for follow-up visits, and dogs that were seen during follow-up visits tended to undergo LCI even if the re-accumulation was small. Some of these mild cases might have healed spontaneously if left untreated. Because prednisolone was prescribed at the time of each LCI, the duration of use was prolonged as the number of LCIs increased. The duration of prednisolone use was not associated with recurrence for AHs treated with the MDH procedure or for all AHs combined, so any possible effects of prolonged prednisolone administration on delayed healing are still uncertain.

A randomized, prospective study²⁹ showed that local injection of triamcinolone can reduce re-accumulation of seromas after breast reconstruction in women. That study suggested that an inflammatory mechanism may strongly contribute to seroma formation because of the efficacy of triamcinolone, a potent anti-inflammatory drug. The results of the

present study and a previous study¹⁵ also suggest a seroma-suppressive effect of triamcinolone because daily needle aspiration alone, even with lavage of the AH cavity, fails to inhibit re-accumulation of fluid in dogs with AHs.¹⁶ Given the negative effects of corticosteroids,^{24,25} these drugs should be used at the lowest effective dosage and for the minimum duration. The anti-inflammatory dose of injectable triamcinolone in dogs is 0.11 to 0.22 mg/kg of body weight or 1.2 to 1.8 mg/lesion.³⁰ Although triamcinolone's effect persists for 7 to 15 days, the injection should be repeated if signs recur.³⁰ A similar dose (0.5 to 2.0 mg, or 0.02 to 0.25 mg/kg) was used in the present study, which was much lower than the oral immunosuppressive dose (0.4 to 0.6 mg/kg).³⁰ In most dogs with AHs, anti-inflammatory doses of triamcinolone may be effective.¹⁵ The transfer half-life of intra-articularly administered triamcinolone to plasma is 5 hours in horses,³¹ and even if the transfer half-life of triamcinolone in the auricular cartilage of dogs is longer, repeated LCI may be needed for AHs with early re-accumulation of fluid requiring therapeutic aspiration. However, the appropriate use of corticosteroids, including the dose, frequency, and duration of triamcinolone or prednisolone, should be investigated further.

The short-term outcomes in the present study indicated that the MDH procedure was superior to the LCI procedure for complete resolution of AHs with one-time treatment. The larger size of the dogs, which tended to have larger AHs, in the MDH group was unlikely to be advantageous for the outcome. An ear bandage was used only in the MDH group, but its application period was short (5 to 7 days), and recurrence was defined as fluid re-accumulation after the first month. Therefore, the lower recurrence rate following the MDH procedure was likely related to the strong adhesions created rather than the short-term bandaging. Nevertheless, we consider that LCI is a good practical method. Recurrences seen after the first month were clinically not problematic because they were easily resolved with 1 or 2 additional LCIs. Only 1 of the 48 (2%) AHs required a change to surgery, which was similar to the percentage in a previous report (1/30 [3%]).¹⁵ Considering the stronger adhesions formed with the MDH procedure than with LCI, we had predicted better long-term outcomes after the MDH procedures. However, no recurrences were observed after 8 months in either group, suggesting that adhesions at the primary AH site became stronger over time regardless of the treatment type. Although changes on palpation were subjectively milder in dogs treated by LCI than by MDH creation, we could not confirm the previously reported better cosmetic result after LCI than surgery,¹⁶ because no cosmetic problems occurred in any cases. Regardless of the treatment outcome, new AHs may develop, and they in fact developed in approximately a third of patients in the present and other studies.¹² For such cases, inexpensive, minimally invasive LCI may

be preferable to repeated surgery; however, surgery should be selected for dogs that do not respond to LCI^{15,22} and for dogs that are aggressive or uncooperative during LCI or that have a chronic AH. Ideally, veterinary practitioners should recognize the short- and long-term outcomes of both treatments and use each according to the patient's characteristics.

This retrospective study had several limitations. First, the 2 treatments could not be fairly compared, because they were performed in different periods, with 6 dogs undergoing both treatments. However, the outcome of the MDH procedures was good, as shown in past reports,^{20,21} and recurrence after LCI was the only problematic outcome. Second, protocols for corticosteroid administration and frequency of follow-up were not uniform. Therefore, whether the effect of the number of LCIs on recurrence resulted from the refractoriness of each AH or the negative effects of repeated LCIs remains unclear. Whether triamcinolone should be used for small re-accumulated AHs is a particularly important issue. A further study that incorporates uniform criteria for treatment and follow-up may be needed to clarify this. With respect to the possibility of overlooking recurrence, this was unlikely because all of our patients visited our clinic regularly, and most visited early if a prominent AH recurred. Third, the exact duration of the AHs before treatment was unknown or uncertain in some cases, preventing us from evaluating the effect of the chronicity of AHs on the treatment outcome. The present results should be interpreted as mainly applicable to acute or subacute cases for which LCI can be performed. Fourth, we should consider the possibility that factors specific to Golden or Labrador Retrievers, which accounted for 43% of all dogs, affected the overall results. Finally, results of statistical testing should be interpreted cautiously considering the small sample size, and larger-scale studies are needed to derive firm conclusion.

The results of the present study supported the hypothesis that the recurrence rate after LCI is higher than that after creation of MDHs and that new AHs are not uncommon in dogs with AHs. Because an increase in the number of LCIs in the first month was associated with an increase in the risk of subsequent recurrences, the negative effect of repeated LCIs should be investigated further. The long-term outcomes suggested that both creation of MDHs and LCI can be therapeutic options for dogs with AHs. However, the risk of new AH development should be considered, especially in retriever breeds and dogs with allergic dermatitis.

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