J Vet Clin 24(4) : 479-485 (2007)

Journal of Veterinary Clinics
www.ksvc.or.kr

A Retrospective Study of 94 Hypercalcemic Dogs (2002-2004)

Tae-Hyung Cho, Byeong-Teck Kang, Chul Park, Dong-In Jung, Jong-Hyun Yoo*, Ju-Won Kim, Ha-Jung Kim, Chae-Young Lim, So-Young Lee, Jung-Hyun Kim, Eung-Je Woo and Hee-Myung Park[1]**

*Department of Veterinary Internal Medicine and *BK21 Program of Intergrative Network Systems for Veterinarians in Basic Science Industrial Animals and Preventive Medicines, College of Veterinary Medicine, Konkuk University, #1 Hwayang-dong, Gwang-jin-gu, Seoul 143-701, and **College of Electronics and Information, Kyunghee University, 1 Seocheon-dong, Giheung-gu, Yongin-si, Gyeonggi-do 446-701, South Korea*

(Accepted: October 4, 2007)

Abstract : A retrospective study of 94 hypercalcemic dogs was performed to find out most common causes that lead to hypercalcemia through investigating dogs referred to the Veterinary Teaching Hospital of Konkuk University from 2002 to 2004. During the study period, hypercalcemia was found in 94 dogs of 19 breeds, and they were evaluated as case group. Control group was made up of 94 dogs of 18 breeds without hypercalcemia admitted for the same study period. For general signalments, there were no significant differences between case and control group with the exception of age distribution. Shih-tzu (17.02%) and Yorkshire terrier (26.60%) was the most common breed in case and control group, respectively. The most common diseases associated with hypercalcemia were chronic renal failure (18.09%), acute renal failure (14.89%), and renal calculi (6.38%). Malignant neoplasia (lymphoma, hemangiosarcoma, chronic lymphocytic leukemia, mammary gland tumor, and multiple myeloma) and endocrinopathies (hyperadrenocorticism, hyperthyroidism, hypoadrenocorticism, and hypothyroidism) occupied 8.5% and 6.4%, respectively. This report is a first retrospective study of hypercalcemic dogs in South Korea.

Key words : dog, hypercalcemia, retrospective study

Introduction

Calcium is a divalent ion essential for normal body function (8). It is working with other ions for building and maintaining strong bones, and also functioning as a messenger or regulatory ion (5). As a regulatory ion, it plays a central role in enzyme function, fat metabolism, nerve transmission, hormonal secretion, blood clotting, muscle growth and contraction, heart function, and facilitating the passage of nutrients through the cell walls (17,18). Calcium normally exists in plasma within the narrow reference range (9.0 to 11.5 mg/dl) by close regulation of intestinal absorption, renal reabsorption or excretion, and the rates of bone resorption and formation (8,12,17). If these regulations are disrupted, hypercalcemia or hypocalcemia can develop.

Hypercalcemia is a well-recognized metabolic abnormality in dogs and occurs when calcium enters the vascular space faster than it can be excreted or sequestered in vessel (8). Elevated serum calcium concentration leads to hyperpolarization of cell membranes and multisystemic manifestations become apparent. Clinical signs of hypercalcemia are vomiting, anorexia, constipation, depression, cardiac arrhythmia, polydipsia/polyuria, seizures, and weakness (3). These signs can not only serve as a marker of disease that help diagnosis but may also contribute to development of lesions. Specific clinical signs necessarily do not accompany hypercalcemia and its presence will frequently be unsuspected (3). Thus, the diagnosis often is made incidentally in asymptomatic patients.

If veterinarians bear the causes and incidence of hypercalcemia in mind, more easy and accurate diagnosis can be available. Many previous studies in Europe and United States have reported that hypercalcemia can be associated with malignant neoplasias, endocrinopathies, renal diseases, hypervitaminosis D, infectious or inflammatory diseases, and other nonpathologic causes (3,6,8,17,22). To our knowledge, there is no retrospective study of hypercalcemic dogs in South Korea.

The purpose of this study is to elucidate the causing diseases in 94 hypercalcemic dogs.

Materials and Methods

Animals

Total 94 hypercalcemic dogs were evaluated and all of them were referred to the Veterinary Teaching Hospital (VTH) of Konkuk University in the period from 2002 to 2004. To avoid lipemia, all dogs were fasted at least 12 hours. Because dogs with age of less than 24 weeks have high values in calcium

T. H. Cho and B. T. Kang contributed equally to this work as the co-first authors

[1]Corresponding author.
E-mail : parkhee@konkuk.ac.kr

concentration (3), they are excluded in this study. Age, sex, breed, environment, and adjusted total serum calcium concentration of hypercalcemic patients were compared with those of 94 eucalcemic dogs admitted during the same study period. In addition, diseases induced hypercalcemia and eucalcemia were investigated and compared.

Adjusted serum total calcium level

Total serum calcium concentration is measured in heparinized plasma by automated machine (Fuji dry-chem clinical chemistry analyzer 3500i, Japan) with spectrophotometric methods. The following formula was used to determine the corrected total serum calcium concentration (11):

Corrected calcium (mg/dl) = measured calcium (mg/dl) – albumin (g/dl) + 3.5

If the corrected total serum calcium concentration exceeded 12.0 mg/dl, it was categorized to hypercalcemia (3). When it had value between 9.0 and 12.0 mg/dl, it was considered to be eucalcemia.

Statistical analysis

The statistical analysis was performed using a software program (SAS version 9.1, SAS Institute Inc., USA). Chi-square test was used to determine the crude association between categorical variables (breed, age, sex, and environment) and the incidence of hypercalcemia. A p-value < 0.05 was considered significant. Odds ratio (OR) were also calculated with 95% confidence intervals.

Results

During the study period, hypercalcemia was found in 94 dogs of 19 breeds and they were belonged to case group. For the same period, 94 dogs of 18 breeds with eucalcemia were allotted to control group. The number and percentage of breeds investigated in both groups are described in Table 1. Percentage of appearance in case group was highest in Shih-tzu (17.02%), then in the order of Cocker spaniel and Yorkshire terrier (11.70%), Maltese (10.64%), Schunauzer (9.57%), Mixed, Pomeranian and Toy poodle (6.38%), Golden retriever (4.26%), Pekinese (3.19%), Miniature pinscher, Poongsan and Pug (2.13%), and others (6 breeds) (1.06%). In control group, it was highest in Yorkshire terrier (26.60%), then in the order of Maltese (18.09%), Shih-tzu (12.77%), Toy poodle (7.45%), Cocker spaniel, Mixed and Schunauzer (5.32%), Chihuahua (4.26%), Pomeranian (3.19%), King Chales spaniel and Miniature pinscher (2.13%), and others (7 breeds) (1.06%). There was no

Table 1. Number and percentage of breeds in the case and control group

Breeds	Case group		Control group	
	Number	Percentage (%)	Number	Percentage (%)
Beagle	1	1.06	0	0
Bull terrier	0	0	1	1.06
Chihuahua	0	0	4	4.26
Cocker spaniel	11	11.7	5	5.32
Dachshund	0	0	1	1.06
Golder retriever	4	4.26	1	1.06
Jindo	1	1.06	1	1.06
King chales spaniel	1	1.06	2	2.13
Kuvasz	1	1.06	0	0.00
Malamute	1	1.06	0	0.00
Maltese	10	10.64	17	18.09
Miniature pinscher	2	2.13	2	2.13
Mixed breed	6	6.38	5	5.32
Papillon	1	1.06	0	0
Pekinese	3	3.19	1	1.06
Pomeranian	6	6.38	3	3.19
Poongsan	2	2.13	1	1.06
Pug	2	2.13	0	0
Schunauzer	9	9.57	5	5.32
Shih-tzu	16	17.02	12	12.77
Soft coated wheater terrier	0	0	1	1.06
Toy poodle	6	6.38	7	7.45
Yorkshire terrier	11	11.7	25	26.60
Total	94	100	94	100

Table 2. Distributions of age in case and control group.

Range of age	Case group		Control group	
	Number	Percentage (%)	Number	Percentage (%)
1	25	26.60	11	12
1-5	35	37.23	46	49
5-9	18	19.15	22	23
> 9	16	17.02	15	16

1: under 1-year-old / 1-5: between 1- and 5-year-old / 5-9: between 5- and 9-year-old / > 9: over 9-year-old

significant relationship between breeds and the incidence of hypercalcemia ($p > 0.05$).

The distributions of age in both groups are shown in Table 2. In case group, the most prominent age ranges between 1- and 5-year-old (37.23%). Similar to case group, in control group, age of the highest incidence rate was between 1- and 5-year-old (49.00%). Age had the lowest incidence rate was appeared in more than 9-year-old in both groups. In case group, hypercalcemia was more frequently shown in dogs aged under 1-year-old compared with control group ($p < 0.01$) (OR, 2.7339; 95% confidence interval: 1.2561-5.9502).

Brief comparisons of chief signalments between two groups are summarized in Table 3.

Mean age was similar in two groups. Each gender was also similarly shown in both groups. Housing environments of two groups were almost indoors. The difference of total mean serum calcium concentration between two groups was approximately 2 mg/dl.

The most common disease related to hypercalcemia was chronic renal failure (CRF) (18.09%), the second was acute renal failure (ARF) (14.89%), and the third was renal calculi (6.38%). Food poisoning (n = 11/31, 35%), which cause was suspected to fungal toxin, was the most common cause of ARF and CRF. Other causes of ARF were diabetic ketoacidosis, heart worm infection, drug toxicosis, glomerulonephritis, and heat stroke. Those of CRF were chronic heart failure, glomerulonephritis, pyelonephritis, and renal calculi. The common types of renal calculi were calcium oxalate and struvite.

Malignant neoplasias such as lymphoma, hemangiosarcoma, chronic lymphocytic leukemia, mammary gland tumor, and multiple myeloma occupied 8.5%. Endocrinopathies inducing hormonal imbalance such as hyperadrenocorticism, hyper- thyroidism, hypoadrenocorticism, and hypothyroidism occupied 6.4%.

When the calcium concentration was separately estimated by four categories of disease, the mean value was 13.8 mg/dl (ARF), 14.0 mg/dl (CRF), 12.6 mg/dl (malignant neoplasia), and 12.6 mg/dl (endocrionopathy).

In total 31 cases, the calcium concentration ranged more than 13 mg/dl. ARF (n = 4), CRF (n = 3), mitral valve insufficiency (n = 1), chronic lymphocytic leukemia (n = 1), pyometra (n = 1), acute hepatitis (n = 1), and mammary gland tumor (n = 1) showed mild hypercalcemia (ranged from 13 to 14 mg/dl). ARF (n = 5), CRF (n = 4), and renal calculi (n = 1) showed moderate hypercalcemia (ranged from 14 to 15 mg/dl). ARF (n = 1), CRF (n = 4), small intestine bacterial overgrowth (n = 1), hyperadrenocorticism (n = 1), food allergy (n = 1), and cystic endometrial hyperplasia (n = 1) showed severe hypercalcemia (ranged more than 15 mg/dl).

In control group, the most common disease was hydrocephalus (10.64%), in the order of tracheal collapse (8.51%), esophageal-gastric foreign body obstruction (7.45%), Babesiosis and canine distemper virus (CDV) infection (4.26%), acute hepatitis, food allergy, hypertrophic cardiomyopathy and immune mediated hemolytic anemia (3.19%), and other 29 diseases (ranged from 1.06% to 2.13%). Malignant neoplasia was not found. However endocrinopathies (hyperadrenocorticism (2.13%) and hypothyroidism (1.06%)) and urologic diseases (renal abscess (1.06%) and urolithiasis (1.06%)) were observed. Percentages of diseases shown in each groups were described in Table 4 and 5, respectively.

Discussion

For general signalments, the present study shows no significant differences between two groups except the distribution of age. In case group, dogs under 1-year-old were more prominent than control group. Among total hypercalcemic 25 cases under 1-year-old, only 4 cases (CDV infection) had the high affinity to young dogs. Thus young age and continuous growing may influence this result. In both groups, most common breeds were small and medium sized, and almost of them lived indoor environment, which reflect the preference of breeds and breeding space in South Korea.

Table 3. Differences of signalments between case and control group

Group	Age (yrs)	Sex (%)		Environment (%)		CTSCC (mg/dl)
	Mean ± SD	M	F	In	Out	Mean ± SD
Case	4.71 ± 4.06	45	55	93	7	13.12 ± 1.18
Control	5.31 ± 3.68	47	53	95	5	11.15 ± 0.61

· SD = Standard Deviation / M: males ; F: females / In: indoor ; Out: outdoor
· CTSCC: Corrected Total Serum Calcium Concentration

Table 4. Distribution of diseases in case group

Diseases	Number	Percentage (%)
Acute hepatitis	1	1.06
Acute renal failure	14	14.89
Allergic conjuntivitis	1	1.06
Atlanto-axial subluxation	1	1.06
Atopy	3	3.19
Canine distemper virus infection	4	4.26
Cerebella trauma	1	1.06
Chronic hepatitis	1	1.06
Chronic lymphocytic leukemia	1	1.06
Chronic renal failure	17	18.09
Cystic endometrial hyperplasia	1	1.06
Demodicosis	4	4.26
Drug eruption	3	3.19
Ehrlichiosis	1	1.06
Endometritis	1	1.06
Erythematous multiform	1	1.06
Food allergy	1	1.06
Gastric foreign body	2	2.13
Heart worm infection	1	1.06
Hemangiosarcoma	1	1.06
Hydrocephalus	2	2.13
Hyperadrenocorticism	2	2.13
Hyperthyroidism	1	1.06
Hypoadrenocorticism	1	1.06
Hypothyroidism	2	2.13
Idiopathic epilepsy	1	1.06
Keratoconjunctivitis cicca	1	1.06
Lymphosarcoma	2	2.13
Mammary gland tumor	3	3.19
Megaesophagus	2	2.13
Mitral valve insufficiency	3	3.19
Multiple Myeloma	1	1.06
Otitis externa	1	1.06
Peritoneopericardial diaphragmatic hernia	1	1.06
Pyometra	1	1.06
Renal calculi	6	6.38
Small intestine bacterial overgrowth	1	1.06
Tracheal collapse	1	1.06
Urinary tract infection	2	2.13

Generally, malignant neoplasia is known for the most common cause of persistent hypercalcemia in dogs, and lymphosarcoma is the most frequent cause of malignancy-associated hypercalcemia (3,17,21,22). Anal sac apocrine gland adenocarcinoma, multiple myeloma, mammary gland- and prostatic gland neoplasia have also been reported in association with hypercalcemia (7,20,22). Mechanisms involved with hypercalcemia of malignancy include local osteolysis induced by osteoclast activating factors (17) and production of PTH-related protein (PTHrp) (24). Ectopic secretion of 1,25-dihydroxycholecalciferol by neoplastic lymphocytes has also been described (6). However, this study showed that malignant neoplasia only occupied 8.5% and this was the third common cause of hypercalcemia. Among malignant neoplasia, lymphosarcoma was the second cause (2.13%) and the first was mammary gland tumor (3.19%).

Table 5. Distribution of diseases in control group

Diseases	Number	Percentage (%)
Acute hemorrhageic gastroenteritis	1	1.06
Acute hepatitis	3	3.19
Aortic stenosis	1	1.06
Atlanto-axial subluxation	1	1.06
Atopy	1	1.06
Babesiosis	4	4.26
Bacterial enteritis	2	2.13
Bronchiectasis	1	1.06
Canine distemper virus infection	4	4.26
Canine parvovirus infection	1	1.06
Cataplexy	1	1.06
Cor p mitrale	1	1.06
Cotricosteroid responsive trremor syndrome	1	1.06
Dermatophytosis	1	1.06
Disk protrusion type	1	1.06
Duodenal ulcer	1	1.06
Eosinophilic enteritis	1	1.06
Exocrine pancreatic insufficiency	1	1.06
Food allergy	3	3.19
Gastric foreign body	7	7.45
Gastritis	3	3.19
Head trauma	1	1.06
Hepatic cirrhosis	1	1.06
Hepatic encephalopathy	1	1.06
Hydrocephalus	10	10.64
Hyperadrenocorticism	2	2.13
Hypertrophic cardiomyopathy	3	3.19
Hypothyroidism	1	1.06
Insulin dependent diabetes mellitus	1	1.06
Inverted sternum	1	1.06
Keratoconjunctivitis cicca	2	2.13
Lymphangiectasia	1	1.06
Mitral valve insufficiency	2	2.13
Noninsulin dependent diabetes mellitus	2	2.13
Normal	3	3.19
Onion toxicosis	1	1.06
Otitis externa	2	2.13
Pancreatitis	1	1.06
Primary immune mediated hemolytic anemia	3	3.19
Pyoderma	2	2.13
Renal abscess	1	1.06
Secondary immune medeated hemolytic anemia	2	2.13
Tracheal collapse	8	8.51
Triamcinolon toxicosis	1	1.06
Urolithiasis	1	1.06
Vertebral instability	1	1.06

These differences may be due to some suspected reasons. First is the difference of preferred breeds. Previous studies of other countries reported that breeds have a higher incidence of lymphosarcoma include Boxers, Basset Hounds, Rottweilers, Saint Bernards, Scottish Terriers, Airedale Terriers, Golden Retriever, and Bulldogs, whereas breeds with lower risk include Dachshunds and Pomeranians (16,13,23). These breeds are almost medium to large sized dogs and relatively small numbers of those has been bred in South Korea. Second is the difference of basal frequencies of each malignant disease at VTH in South Korea when comparing to those of other countries such as North America and European countries. Last is the lower number of malignant dogs referred to VTH in South Korea than other countries due to owner's economic burden for the treatment or insufficiency of awareness about animal welfare.

In previous studies, CRF is the third cause of hypercalcemia in dogs (2,3,4,6). However, in this study, the most common cause of it was renal disease, such as CRF, ARF, and renal calculi. Most dogs with ARF (n = 10) and CRF (n = 11) had high calcium concentration ranged more than 13 mg/dl. During the study periods, many dogs were suffered from renal failure due to food poisoning. Even though these dogs were excluded from this study, ARF (8.5%) and CRF (12.8%) were highly related to hypercalcemia. For the same periods, 19 dogs with ARF or CRF did not have hypercalcemia. It has been reported that most total serum calcium levels of dogs with CRF range from 12.0 to 13.0 mg/dl (8). However, in this study, those (ranged from 12.2 to 15.8 mg/dl) were higher than previous study. It is supposed that many referred dogs with CRF had not been well managed for tertiary hyperparathyroidism. One author reported that hypercalcemia associated with CRF is usually found in dogs less than 1-year-old, often in a breed affected with familial renal disease such as the Lhasa Apso and Shi-tzu (10). In this study, Shi-tzu occupied 59% of dogs with CRF. However, only 3 dogs (17.6%) were less than l-year-old and Lhasa Apso with CRF was not found. It was also reported that hypercalcemia in association with CRF is not restricted to the young dog (3). Even though Shih-tzu is one of the most preferred breeds in South Korea and non-correlation between CRF and Shih-tzu was suggested (14), it should be needed for further studies to verify this relationship.

Hypoadrenocorticism has been reported as the second common cause of hypercalcemia in dogs (4,15,25). However our study showed that other endocrinopathies (hyperadrenocorticism, hyperthyroidism, and hypothyroidism) had the higher frequency than hypoadrenocorticism. In this study, number of dogs with hypoadrenocorticism was only one (1.06%) in case group and none in control group. Other three endocrionpathies occupied 5.32% and 3.19% in case and control group, respectively. Because those were concurrently shown in both groups, hypercalcemia may be not closely related to these diseases.

Hypervitaminosis D and primary hyperparathyroidism are uncommon causes for hypercalcemia in dogs (1,3,4). Both diseases were not found in this study. Until recently, marketing of vitamin D (cholecalciferol)-containing rodenticides has increased of acute vitamin D toxicoses in animals (9). Because most dogs in South Korea bred inside the house, they may have relatively low chances of exposure to rodenticides.

Total frequency of other diseases except malignant neoplasia, renal failure, and endocrinopathy was up to 46% in case group. However, it couldn't be said that those are common causes of hypercalcemia because incidence rate of each disease was relatively low (ranged from 1.06% to 4.26%). Thus, relationship between hypercalcemia and those should be more studied.

In conclusion, common causes of hypercalcemia of dogs referred to the VTH of Konkuk University were similar to other countries. However, the frequencies of each disease were different. Thus, more studies throughout the country are necessary to know the causes of hypercalcemia exactly. If these are performed, obtained results could help veterinarians in South Korea with differentiating diseases inducing hyperclacemia.

Acknowledgment

This work was supported by the SRC/ERC program of MOST/KOSEF (R11-2002-103).

References

1. Berger B, Feldman FC. Primary hyperparathyroidism in dogs: 21 cases (1976-1986). J Am Vet Med Assoc 1987; 191: 350-356.
2. Chew DJ, Capen CC. Calcium nephropathy and associated disorders. In: Kirk's Current veterinary therapy, VII 7th ed. Philadelphia: W. B. Saunders. 1980: 1067-1072.
3. Chew DJ, Carothers M. Hypercalcemia. Vet Clin North Am Small Anim Pract 1989; 19: 265-287.
4. Chew DJ, Meuten DJ. Disorders of calcium and phosphorous metabolism. Vet Clin North Am Small Anim Pract 1982; 12: 411-438.
5. Ebashi S. Ca^{2+} in biological systems. Experientia 1985; 41: 978-981.
6. Kruger JM, Osborne CA, Nachreiner RF, Refsal KR. Hypercalcemia and renal failure. Etiology, pathophysiology, diagnosis, and treatment. Vet Clin North Am Small Anim Pract 1996; 26: 1417-1445.
7. Lauel EW, John MG, Richard KD, Jeffrey LJ, Rance MG, Douglas HT, Susan EL, Mary S, Antony SM. Carcinoma of the apocrine glands of the anal sac in dogs: 113 cases (1985-1995). J Am Vet Med Assooc 2003; 223: 825-831.
8. Martin LG. Hypercalcemia and hypermagnesemia. Vet Clin North Am Small Anim Pract 1998; 28: 565-585.
9. Mellanby RJ, Mee AP, Berry JL, Herrtage ME. Hypercalcaemia in two dogs caused by excessive dietary supplementation of vitamin D. J Small Anim Pract 2005; 46: 334-338.
10. Meuten DJ. Hypercalcemia. Vet Clin North Am Small Anim Pract 1984; 14: 891-910.

11. Meuten DJ, Chew DJ, Capen CC, Kociba GJ. Relationship of serum total calcium to albumin and total protein in dogs. J Am Vet Med Assoc 1992; 180: 63-67.
12. Nelson RW, Turnwald GH, Willard MD. Endocrine, metabolic, and lipid disorders. In: Small animal clinical diagnosis by laboratory methods. 4th ed. St. Louis: W. B. Saunders. 2004: 166-167.
13. Onions DE. A prospective survey of familial canine lymphosarcoma. J Natl Cancer Inst 1984; 72: 909-912.
14. O'Brien TD, Osborne CA, Yano BL, Barnes DM. Clinico-pathologic manifestations of progressive renal disease in Lhasa Apso and Shih Tzu dog. J Am Vet Med Assoc 1982; 180: 658-664.
15. Peterson ME, Feinman JM. Hypercalcemia associated with hypoadrenocorticism in sixteen dogs. J Am Vet Med Assoc 1982; 181: 802-804.
16. Priester WA, McKay FW. The occurrence of tumors in domestic animal. J Natl Cancer Inst 1980; 54: 1-210.
17. Rosol TJ, Capen CC. Pathophysiology of calcium, phosphorus, and magnesium metabolism in animals. Vet Clin North Am Small Anim Pract 1996; 26: 1155-1184.
18. Rosol TJ, Chew DJ, Nagode LA, Capen CC. Pathophysiology of calcuim metabolism. Vet Clin Pathol 1995; 24: 49-63.
19. Ruslander DA, Gebhard DH, Tompkins MB, Grindem CB, Page RL. Immunophenotypic characterization of canine lymphoproliferative disorders. In Vivo 1997; 11: 169-172.
20. Sarah JL, Mark CW, Robert LG. Unusual IgM-secreting multiple myeloma in a dog. J Am Vet Med Assooc 2003; 223: 645-648.
21. Teske E, van Heerde P, Rutteman GR, Kurzman ID, Moore PF, MacEwen EG. Prognostic factors for treatment of malignant lymphoma in dogs. J Am Vet Med Assoc 1994; 205: 1722-1728.
22. Uehlinger P, Glaus T, Hauser B, Reusch C. Hypercalcemia in dogs – A retrospective study of 46 cases. Schweiz Arch Tierheilkd 1998; 140: 188-197.
23. Vail DM, MacEwen EG, Young KM. Canine lymphoma and lymphoid leukemias. In: Small animal clinical oncology, 3rd ed. Philadelphia: W. B. Saunders. 2001: 558-590.
24. Weir EC, Burtis WJ, Morris CA. Isolation of 16,000 dalton parathyroid hormone like proteins from two animal tumors causing humoral hypercalcemia of malignancy. Endocrinology 1988; 123: 2744-2751.
25. Willard MD, Schall WD, McCaw DE, Nachreiner RF. Canine hypoadrenocorticism: report of 37 cases and review of 39 previously reported cases. J Am Vet Med Assoc 1982; 180: 59-62.

94 마리 고칼슘혈증 개들에 대한 회고연구 (2002-2004)

조태형 · 강병택 · 박 철 · 정동인 · 유종현* · 김주원 · 김하정 · 임채영 · 이소영 · 김정현 · 우응제 · 박희명**[1]**

건국대학교 수의과대학 내과학 교실
*BK21 수의기초 · 산업동물 · 예방의학 통합네트워크 연구인력 양성 사업단
**경희대학교 전자정보대학 동서의료공학과

요 약 : 2002년부터 2004년 까지 건국대학교 부속동물병원에 의뢰된 환축 중 고칼슘혈증견을 나타내는 94마리를 대상으로 원인질병을 조사하였다. 연구 기간 동안 고칼슘혈증은 총 94 마리, 19 견종에서 발견되었으며, 이들을 증례군에 포함시켰다. 대조군은 동일 연구기간 동안 고칼슘혈증이 발생되지 않은 총 94마리, 18 견종으로 구성되어졌다. 일반 품고 들에 대해서는 나이 분포를 제외하고는 증례군과 대조군 간에 현저한 차이가 없었다. 시츄 (17.02%)와 요크셔 테리어 (26.60%)가 증례군과 대조군에서 각각 가장 일반적인 품종이었다. 고칼슘혈증의 가장 일반적인 원인은 만성 신부전 (14.89%) 이었으며, 그 다음으로 급성 신부전 (14.89%), 신결석 (6.38%) 순이었다. 악성종양 (림프종, 혈관육종, 만성 림프구성 백혈병, 유선 종양 및 다발성 골수종)과 내분비계 질환 (부신피질 기능항진증, 갑상선 기능항진증, 부신피질 기능저하증 및 갑상선 기능저하증)은 고칼슘혈증의 원인 중 8.5%와 6.4%를 각각 나타내었다.

주요어 : 개, 고칼슘혈증, 회고연구