

## Nailbed Epithelial Inclusion Cysts in Two Dogs

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**Abstract :** A 5-year-old, 6.2 kg male mixed dog was presented to local animal hospital with a 6-month history of swelling, pain, inflammation, and lameness in the 5th digit of right hind limb. And a 7-year-old, 2.7 kg male Maltese dog was also presented to animal hospital with a 2-month history of nail deformities in the 5th digit of left hind limb. Abnormal growth or degeneration of the distal phalanges was observed at the 5th digit of hind limb in two dogs using radiographic examination. The masses in the digit were excised completely under local anesthesia. On histological examination of the digit masses, large well-circumscribed, unencapsulated round or irregular cystic neoplasms with/without inflammation were occupied in or adjacent area of the distal phalanx. These cysts were lined by stratified squamous epithelium that occasionally had a prominent granular cell layer. Based on the history, clinical signs, radiographic, gross and histopathologic features, these cases were diagnosed as nailbed epithelial inclusion cysts in the digit of dogs.

**Key words :** Digit, distal phalanx, dog, hind limb, nailbed epithelial inclusion cyst.

### Introduction

Nailbed (human term “subungual”) epithelial inclusion cyst (NEIC) is a non-neoplastic simple cyst lined by a stratified squamous epithelium that is present within the bone of the third phalanx (4). NEIC is most likely a result of trauma leading to embedment of portions of cuticular epidermis or germinative nailbed epithelium in subjacent connective tissues (6). NEIC has a similar histologic appearance to follicular cysts of infundibular origin. Subungual epidermoid cysts are rarely reported in human (8). Epithelial inclusion cysts also occur infrequently in the nailbed of dogs and cats (6).

Cutaneous cyst may be defined as a non-neoplastic, simple sac-like structure with an epithelial wall and keratinous to amorphous contents (3). The majority of cysts in the skin of dogs and cats are of follicular origin (5). Classification of cutaneous cysts depends on identification of the lining epithelium or the pre-existing structures from which the cyst arose. Follicular cysts are usually classified according to the differentiation of their epithelial lining into infundibular, isthmus, metrical, and hybrid cysts (5). Infundibular cysts have been previously called epidermoid cyst, epidermal inclusion cyst and epithelial inclusion cyst (3). In this report, we described two cases of NEIC in the digits of dogs in Korea.

### Case

A 5-year-old, 6.2 kg male mixed dog (case 1) was presented to local animal hospital with a 6-month history of

swelling, pain and inflammation in the 5th digit of right hind limb. Because of digital mass with about 1 cm diameter, this dog showed hind limb lameness. No previous trauma to the digit could be recalled. And a 7-year-old, 2.7 kg male Maltese dog (case 2) was also presented to animal hospital with a 2-month history of nail deformities with thick and lengthened nail in the 5th digit of left hind limb. Abnormal growth of the distal phalanx and edema of the dermis were observed at the 5th digit of right hind limb in mixed dog using radiographic examination (Fig 1A). Degeneration of the distal phalanx was also noted at the 5th digit of left hind limb in Maltese dog (Fig 1B).

The masses in the digits were excised completely under local anesthesia. After surgery, the masses were fixed in 10% buffered formalin, and submitted to the pathology laboratory at the College of Veterinary Medicine in Jeju National University. After the decalcification in formic acid-formalin solution for 2 or 3 days, submitted masses were trimmed, embedded in paraffin, sectioned at 3  $\mu$ m, and stained with hematoxylin and eosin (H&E) for light microscopic examination.

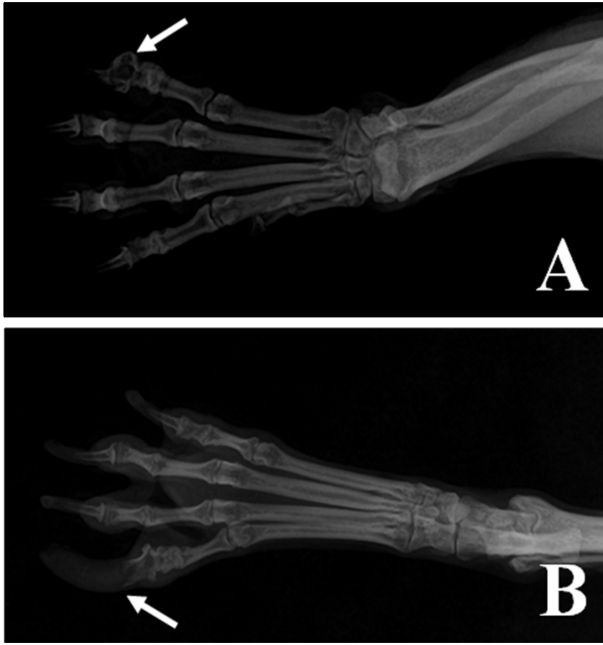
Grossly, requested digits showed severe swelling with dark brown color. Solitary pale yellowish cyst-like mass was occupied in beneath area of nail in the cut-surface of affected digits in two dogs (Fig 2). The size of masses was 3  $\times$  6 mm in mixed dog and 2  $\times$  3 mm in Maltese, respectively. Pale brown discoloration was also observed at the dermis of claw fold in the digit of mixed dog.

On histological examination of the digit masses, large well-circumscribed, unencapsulated round or irregular cystic mass was occupied in (case 1) or adjacent area (case 2) of the distal phalanx (Fig 3A, 3B). Two cysts showed the same histopathologic characteristics. In these cystic structures, spherical core of laminating keratin was surrounded by a wall of

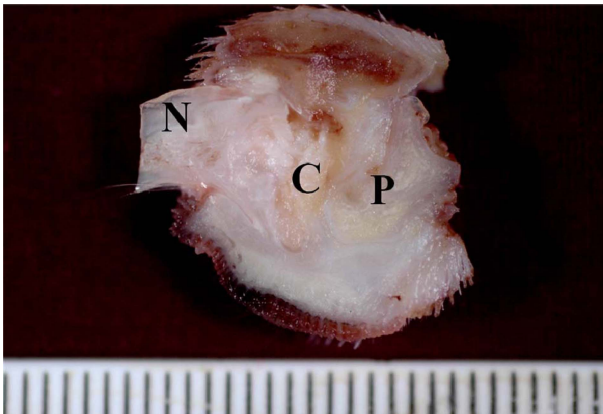
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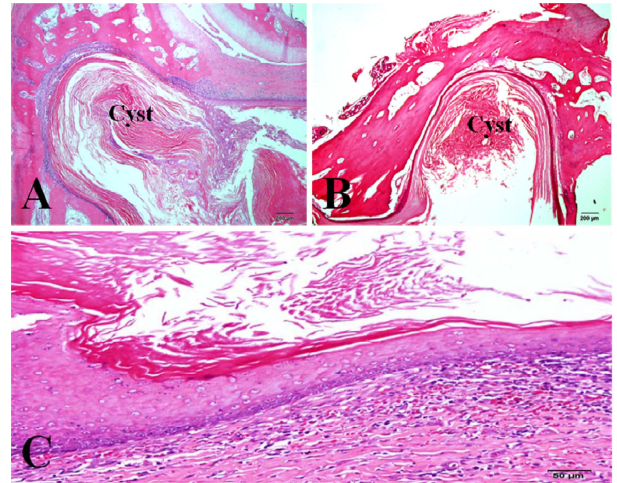


**Fig 1.** Radiographs showed abnormal growth of the distal phalange at the 5th digit of right hind limb in mixed dog (A). Note degeneration of the distal phalange at the 5th digit of left hind limb in Maltese dog (B).

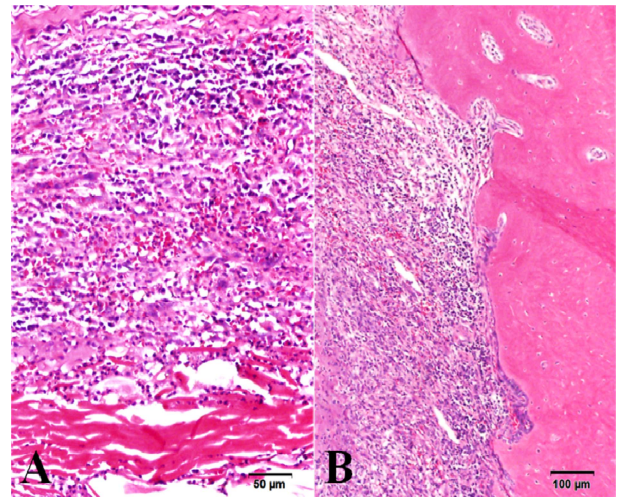


**Fig 2.** Single pale yellowish cyst-like mass (C) was occupied in beneath area of nail (N), adjacent third phalanx (P) in the cut-surface of the digit.

moderate proliferated stratified squamous epithelium without attachment of the adnexa structures. The center of cores composed of nearly normal keratin (case 1) and mixed with RBCs (case 2). These cysts were lined by stratified squamous epithelium that occasionally had a prominent granular cell layer (Fig 3C). Because of partial rupture of cyst in case 1, there were severe inflammatory foci composed of neutrophils, macrophages, and multi-nucleated giant cells in upper area (dermis of claw fold) of cyst (Fig 4A). Lots of keratin remnants, RBCs and protein fluids also existed in this inflammatory focus. This inflammatory process extended into bony tissues of the distal phalanx (Fig 4B). Multifocal lymphocytic infiltration also presented around blood vessels in the dermis. Because of the cyst in case 2, the distal phalangeal bone showed mild atrophy.



**Fig 3.** Histopathologic findings of nailed inclusion cysts in dogs. Note large well-circumscribed and unencapsulated cystic masses (Cyst) in (A, case 1) or adjacent area (B, case 2) of distal phalanx. H&E, Bar = 200  $\mu$ m. Cyst was lined by stratified squamous epithelium with prominent granular cell layer (C). H&E, Bar = 50  $\mu$ m.



**Fig 4.** Note inflammatory foci around partial ruptured cyst (A). H&E, Bar = 50  $\mu$ m. This inflammatory process extended into bony tissues of the distal phalanx (B). H&E, Bar = 100  $\mu$ m.

## Discussion

Based on the history, clinical signs, radiographic, gross and histopathologic features, these cases were diagnosed as NEIC in the digits of dogs. Various types of tumors can affect the subungual space in nails of human. Subungual tumors include benign solid tumors (glomus tumor, soft-tissue chondroma, keratoacanthoma, and hemangioma), benign cystic lesions (epidermal and mucoid cysts), and malignant tumors (squamous cell carcinoma and malignant melanoma) (1). Magnetic resonance (MR) imaging and high-resolution ultrasonography with color Doppler studies can provide useful information regarding tumor size, location, shape, and internal characteristics (cystic, solid, or mixed) of subungual disease (1). However, primary nailed tumors are uncommon in

dogs and rare in cats (6). In animals, nailbed tumors include malignant tumors (squamous cell carcinoma, basal cell carcinoma, and malignant melanoma), benign tumors (keratoacanthoma and inverted papilloma), and cystic lesion such as NEIC (4,6). Benign NEICs are analogous to follicular cysts of infundibular origin, occur infrequently in the subungual region in dogs (7). Histopathologic findings of two digit masses in this study corresponded to NEIC resemble infundibular cysts in the skin. As previously described (3,5,9), infundibular cysts were lined by squamous epithelium with an obvious granular cell layer, as in the upper portion of the normal follicle. In these cases, the lining epithelial cells of two cysts in nailbed had typical granular cell layer. Therefore, the present cases support evidences of NEIC in the digits of dogs.

The pathogenesis of cutaneous follicular cysts in dogs is usually unknown but in some cases may be a result of repeated external trauma to the skin surface, such as callus formation over bony pressure-points, or congenital anomaly of epidermal development (5,9). External trauma induces plugging or narrowing of follicular ostia causing retention of follicular contents. Consequently, the retention of follicular contents causes dilation and, eventually, formation of follicular infundibular cysts (2). Although the exact pathogenesis of subungual epidermal cysts in human remains controversial, it is believed that these lesions are caused by entrapment of epidermal fragments in other tissues of the digits by any type of injury, including trauma or an iatrogenic injury, or by migration of nail bed fragments into ectopic sites (1). Intraosseous epidermal cysts affect the phalanges of the hands and feet in human (1). Several previous studies suggest that the origin of phalangeal cysts is either directly related to traumatic implantation of epidermal fragments into the bone by any type of injury or due to a migration of a fragment of nail bed into the phalangeal bone (10). NEIC in animals also closely related with the previous trauma (6). However, many but not all cases are associated with trauma (6,8). The cause of NEIC in this study was remained unknown, and did not connect with trauma according to clinical history. Recent case report demonstrated subungual cyst formation associated with cutaneous viral papilloma in a dog. The virus induced inverted papilloma, located at the junction of the digital paw pad and ventral nail, extended focally through the nail into the subungual space, where an expansile epithelial inclusion cyst was formed in this dog (7).

Intraosseous epidermal inclusion cyst is more commonly affected in man than women, and frequently located in the terminal phalanges of the fingers, especially the middle fingers (10). This phenomenon is closely involved with potential traumatic injury. The prevalence of interdigital follicular cysts in dogs with mean weight of 45 kg was greater in the front than the hind paws (2). In addition, the vertical forces in the fore limb were greater than those in the hind limb during walking in greyhounds and Labrador retrievers. These findings indicate that more weight bearing occurs on the front than on the hind paws of heavy breed dogs. Therefore trauma was proposed as a cause of interdigital cysts in dogs. However, two cases of NEIC in this study were occupied in hind limb of small breed such as mixed and Maltese dog,

weighing 6.2 and 2.7 kg, respectively. Hence the effect of weight bearing and vertical forces influenced on the occurrence of interdigital cysts for limbs in small breed dogs might be milder than those in large heavier breed dogs. There is no known age or breed predilection in canine NEIC (6). Previous onychectomy sites and declaws are affected most often in the cases of canine NEIC (6).

Follicular cysts usually present as solitary, firm, intradermal or, occasionally, subcutaneous nodules ranging from 0.2 to 2 cm in diameter. Partial or total alopecia without any severe clinical signs may be present (6), whereas the primary presenting sign is single swollen digit in dogs with NEIC. The nail may be cracked or irregular. The most common symptom in human with subungual epidermal inclusion cyst is swelling of the fingertip with redness, pain, and a "hot" sensation (1). Most benign subungual tumors cause nail deformation due to chronic pressure at some point on the matrix or the nail bed in human (8). Clinical lameness in dogs was likely associated with pain caused by the expanding subungual cyst and pyogranulomatous inflammation subsequent to rupture of the cyst wall with release of keratin into the surrounding tissue. Pressure-induced bone lysis by subungual cyst expansion and mild periosteal bone proliferation have been reported in association with subungual inclusion cysts (6,7). In the present study, nail deformity with pressure atrophy of the distal phalanx and pyogranulomatous inflammation in the dermis of claw fold and the distal phalanx were observed in mixed dog and Maltese dog, respectively. This inflammation was probably secondary to focal rupture of the cyst in Maltese dog. NEIC induced inflammation in the dermis and bone may increase the severity of pain and hind limb lameness in this dog.

Clinical management of small numbers of individual cutaneous follicular cysts is surgical excision or observation without treatment (9). The nail biopsy may be both diagnostic and therapeutic in human with subungual epidermoid cyst if the cyst is completely excised (8). According to previous study of nail and nailbed lesions in dogs, in which only 12% (24/196) claw disorders were neoplastic diseases, but large scaled recent study indicated that neoplastic diseases, both benign (15.7%) and malignant (53.5%), composed the largest proportion of abnormalities in 404 surgically amputated canine digits (11). Benign neoplasms and non-neoplastic lesions in this study included epithelial inclusion cyst (20 dogs), keratoacanthoma (15 dogs), sebaceous adenoma (5 dogs) and follicular cyst (3 dogs). Therefore MR imaging, ultrasonography and histopathologic examination for nailbed lesions should be performed to achieve accurate diagnosis and to choose proper treatment.

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