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선천성 갑상선종에 의한 무모 돼지 발생

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Occurrence of Hairless Piglets with Congenital Goiter

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Abstract: A diagnosis of iodine-deficient goiter was confirmed in newborn piglets that were born hairless edematous, and with markedly enlarged thyroid gland. Clinically, most of the piglets were born dead, extreme weakness or dying within a few hours of birth. Gestation periods were prolonged for 3-7 days. Histopathologically, hair follicles were scarce and reduced in size, contained slender hairs, and revealed a shallow penetration into the hypodermis that showed severe diffuse edema. Thyroid glands had severely hyperplastic follicles and poorly staining colloid. The follicles were irregular in size and shape depending on varying amounts of lightly eosinophilic and granular colloid in the lumen. The iodine content of the diet fed to the sows and plasma total thyroxine and triiodothyronine concentration of sows were very low. This is a first report for iodine-deficient goiter in newborn piglets in Korea.

Key words: piglet, iodine, goiter, skin, thyroid gland

Introduction

Hairlessness or hypotrichosis in pig has been associated with hereditary condition, goitrogenic compounds, and a deficiency of iodine in the diet of a sow during pregnancy [6, 9]. Based on the investigation of the parentage of pig litter with congenital goiter, Welchman et al [11] found the statistic autosomal recessive mode of inheritance between hairless and normal piglets. Another inherited form of hairlessness has been described in piglets as part of the barker or neonatal syndrome [13] although it was not accompanied by goiter. Congenital goiter has also been arisen in pigs when dietary constituents, such as thiouracil [6], sulfadimethoxine and ormetoprim [2] that interfere with the synthesis of thyroid hormone are fed to the sow. The deficiency of iodine in the diet of a sow in pregnancy can lead to birth dead of weak, partially or completely hairless piglets which have an enlarged thyroid gland (goiter) [6, 9]. Because of the lacking skin hair, these pigs are very sensitive to environmental condition and lead to retard growth. Hairless newborn pigs were prevalent in large area of northwestern USA in the early 20th century [7] and Japan in the late 1970 [5]. Iodine deficiency that resulted in diffuse thyroid hyperplasia was common in

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many goitrogenic areas throughout the world, the outbreaks are sporadic and fewer animals are affected. Herein, we described the first case of hairless piglets with congenital goiter associated with iodine deficiency in the feed of sows in Korea.

Materials and Methods

Case histories

From middle in May 1998, a disease outbreak characterized by hairless piglets at birth followed by death in three sow herds located in Kyunggi-Do, a northern province of Republic of Korea. A total of 22 litters (4-10 litters in each herd) were affected with this disease, and the average of 4-5 piglets per litter was die. Most of the piglets were born dead, extreme weakness or dying within a few hours of birth. The litters with affected piglets were born after gestation periods of 117 to 121 days, longer than the mean of 114 days for normal litters. The herd has been operated by continuous flow system and routinely has been vaccinated for classical swine fever virus, porcine parvovirus, Japanese encephalitis virus, and a few bacterial respiratory pathogens.

Necropsy and histopathology

In late June 1998, 7 dead 2 to 5-day-old piglets from 2 farms and 2 sera of sows from a farm were submitted to the Pathology Division of the National Veterinary Research and Quarantine Service for diagnostic investigation. The examination included gross finding, the removal and weighing of the thyroid gland.

After postmortem examination, tissue samples from the skin, thyroid gland, lung, heart, liver, kidney, spleen, lymph node, and brain were fixed in 10% phosphate- buffered formalin, routinely processed, and stained with hematoxylin and eosin for light microscopic examination. Especially specimens of skin were collected from the head, neck, frontal limb, and back. Replicate sections of the skin were also stained with Periodic Acid-Schiff (PAS), and alcian blue (pH 2.5) stains.

Radioimmunoassay for blood

Blood samples were taken from two sows that gave birth to hairless piglets within 5 days of farrowing. Sera were separated within 5 hours of collection and frozen at -20℃ for next analysis. The concentration of total plasma thyroxine (TT4) and triiodothyronine (T3) levels in the sera was measured by radioimmunoassay, using Gamma-B T4 and T3 radioimmunoassay kits (Immunodiagnostic System).

Iodine assay

Two samples of feeds for sows made by same company obtained from different farms were analyzed for iodine contents. One sample was derived from the farm occurring hairless piglets, and another sample from normal farm in same province. The feed samples were referred to the Advanced Analysis Center in Korea Institute of Science and Technology, analyzed with the inductively coupled plasma/mass spectrometer (ICP-MS) method for iodine content. The minimal detectable dose of this assay was 0.05 mg/kg.

Results

Gross findings and histopathology

Grossly, the 7 piglets had shiny or wrinkled skin and partially or completely hairless in the body, limbs, distal region, with exception of a small tuft of hair on the head and muzzle. The skin was thickened with considerable gelatinous materials in subcutis being more prominent on the neck, shoulders, and hind limbs (Fig. 1). The thyroid glands of all piglets were marked, enlarged and dark red (Fig. 2). The average of thyroid gland was 1.6 × 1.2 × 0.7 cm in size. The thyroid gland of affected piglets weighed between 1.3 and 2.7 g, most of that heavier than normal values ranged from 0.08 to 0.54 g in newborn piglets [12].

Fig. 1. The hairless and swollen appearance of the skin in a 2-day-old piglet.

Fig. 2. Enlarged and dark red thyroid gland (arrow) in the hairless piglets.

Most of the piglets examined had common lesions in the skin and thyroid gland within mild to moderate degree. The epidermis of skin was thin with a single layer of stratum basal cells, the prickle cells with large vacuolar cytoplasm, and a poorly keratinized stratum corneum. The papillary and reticular layers of the dermis were not distinct and composed of loose areolate structure.

Hair follicles were scarce, and contained slender hairs varying in size (Fig. 3). Many hair bulbs did not penetrated into the hypodermis. Many mature hair follicles were distorted and reduced in size ranged 5-8 um, being two-thirds in diameter compare the normal hair follicles. In some hair follicles, central follicle was demonstrated, and lateral follicles had only remnants of hair pegs. The slender hairs located in the center of hair follicles were mainly composed of cortex without medulla. Most of the lesions were variable depend on the site of skin and piglets involved.

Fig. 3. Skin. There is scarcity of hair follicles reduced in size and contained slender hairs. H&E. ×40. Inset, a central hair follicle has a widened internal root sheath and the primordium of a sebaceous gland (arrow). H&E. ×400.

Hypodermis showed severe diffuse edema in all of piglets. Basic architectures such as blood vessels, cellular components, and connective tissue were widely separated by large amounts of the unstained background materials. The composition of ground material was clarified as mucin by PAS and alcian blue staining. Arrector pili muscles and sebaceous glands were existed in some regions, but they were not frequently observed in areas showing a scarcity of hair follicles. In severely affected cases, the primordium of a sebaceous gland was occupied in the central hair follicles (Fig. 3, inset).

Thyroid glands had severely hyperplastic follicles and poorly staining colloid. The follicles were irregular in size and shape depending on varying amounts of lightly eosinophilic and granular colloid in the lumen. The lining epithelia of the follicles were cuboidal to columnar with pale cytoplasm and dark stained nuclei at the base. Some of the apparently hyperplastic epithelia showed papillary projection into the lumen (Fig. 4). The blood vessels in the interstitial tissue were dilated and congested.

Fig. 4. Thyroid gland. Hyperplastic follicles lined with columnar epithelium protruded into the lumen and contained pale colloid fluid and cellular debris. H&E. ×100.

Radioimmunoassay and iodine assay

According to radioimmunoassay, the total plasma thyroxine and triiodothyronine concentration in sows were 1.04 to 1.25 μg/dl, and 19.52 to 44.22 ng/dl, respectively. The mean serum thyroxine concentration of sows producing normal litters, sampled three days after farrowing, was reported to be 42.5 nmol/litre (nmol/l = μg/dl × 12.9) [3]. Two sows had markedly decreased blood levels of

thyroxine and triiodothyronine.

An analysis of feed between from normal farm and affecting farm revealed an iodine contents of 0.94 mg/kg and less than 0.05 mg/kg, respectively. The iodine content of normal farm was well above the figure of 0.9 mg/kg recommended for sow diets (National Research Council: NRC, 1998) [10]. But in affected farm, the iodine content of sow diet was detected below the minimum limit values in ICP/MS method.

Table 1. Plasma thyroxine and triiodothyronine concentration in sows

Number of sows	Plasma thyroxine (μg/dl)	Triiodothyronine (ng/dl)
96	1.04	19.52
281	1.25	44.22
Normal range(mean)*	1.70-4.68(3.32 ±0.80)	43-140(89.8 ±36.7)

*McDonald, L.E. and Pineda, M.H. [8].

Discussion

Based on the results of clinical signs, gross pathology, histopathology, and assays for sera and diet of sows, piglets were diagnosed as congenital goiter due to iodine deficiency in the sow during pregnancy. Congenital hypothyroidism is characterized by the prolongation of gestation, and thyroid hyperplasia and hairlessness and myxedema in skin [6]. Because of the prolonged gestation periods and the birth to dead, we checked several infectious diseases such as Japanese encephalitis virus, porcine parvovirus, encephalomyocarditis virus, and pseudorabies virus. But there was no evidence of infectious diseases in sow and piglets (data not shown).

In the present study, the histopathologic lesions in skin and thyroid gland of these piglets were compatible with previous studies for hypothyroidism [5, 11]. According to the study of Fowler and Calhoun [4], many of hairs were fully formed and were raised from the surface by the 95th day of swine fetal life. Histologically, the skin lesions were classified into hypoplasia of the hairs and severe myxedema in hypodermis. The follicular epithelium of the thyroid gland was hypertrophic and hyperplastic, causing the parenchymatous goiter to produce more thyroxine. These characteristic lesions were closely related with hypo-function of thyroid gland. Hypothyroidism results from a subnormal amount of circulating thyroid hormone, and has numerous etiologies, some thyroidal and others of extrathyroidal origin. The affected piglets in this study were similar to the piglets affected with the barker syndrome that has also been shown to be an inherited trait [13]. The similar respects included the prolongation of gestation, hairlessness in newborn piglets, low serum thyroxine in the affected piglets. However, the piglets in this study differed from barker piglets that have a small thyroid gland rather than with the enlargement of the thyroid gland. And in the lung lesions, there was no evidence of necrosis of alveolar epithelium and hyaline membranes.

Because of the similar histopathologic lesions in hypothyroidism regardless of different factors, it is very difficult to confirm the causes based on the lesions. Plasma thyroxine and thyroid stimulating hormone are used in the screening for thyroid disorders in human infants [1]. The most sensitive and accurate method for evaluation of thyroid function is measurement of blood thyroxine and triiodothyronine levels by radioimmunoassay [6]. Feeding of iodine-deficient diets to sows result in inadequate thyroxine synthesis and decreased blood thyroxine and triiodothyronine in the sows of present study. National Research Council [10] suggested that sows of 145 to 185 kg live weight at farrowing, housed at 18 to 20℃ and with daily feed intakes of 4.4 to 6.1 kg of a corn-soybean diet. Iodine requirement of gestation and lactating sows is 0.14 mg/kg of diet based on the daily consumption of 1.85 and 5.25 kg of feed. However, the iodine content of sow diet in affected farm was below the minimum detectable values at 0.05mg/kg in ICP/MS method.

Now iodine supplementation is common in pig feeds [9]. Although iodine-deficient goiter occurs in large area of the world in several domestic animals, the outbreaks are sporadic. Although the economic effects of goiter in the pig herd were limited, there had been no successful treatment for the congenital goiter. Supplement of iodine in feed of early gestation period can prevent this disease especially in many goitrogenic areas.

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