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Oral manifestations of Systemic Diseases: An Insight from Radiological Imaging

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ABSTRACT

"systemic disease" will be understood as conditions that are distributed throughout the body rather than confined to the tissues in the oral cavity. Systemic diseases such as endocrine system disorders, bone metabolism disorders and other diseases can affect the shape and function of bones and teeth. Dental radiographs provide information that is important for the diagnosis of systemic disease. It is the first indication that leads to early diagnosis. Oral radiographic manifestations are not always seen in a given patient. The degree of expression of the radiograph can vary greatly and may be indicative of the degree and duration of systemic disease. A lot of systemic diseases come with oral manifestations. In fact, the oral cavity can be considered the "window to the body" as many systemic diseases are accompanied by oral manifestations. Proper recognition of these oral manifestations is essential for proper diagnosis and referral for treatment. As it would take a large number of volumes to list all such conditions, it is the intention to review a radiographic findings indicated widespread disease of sufficient magnitude to impact the patient's quality of life and lifespan. In this article, you'll find a guide on how to identify oral manifestations of systemic diseases radiographically and also imaging findings of a few of these dentofacial presentations are briefly discussed

Keywords: Radiographic findings, oral manifestations, systemic diseases, dental radiographs, patient care.

1. INTRODUCTION

The human oral cavity is more than just a gateway for nourishment and communication; it serves as a sentinel, offering crucial insights into an individual's overall health and well-being. This intricate ecosystem, exposed to a constant influx of microorganisms, poses a perpetual challenge, reflecting not only local dental health but also systemic conditions that may affect the entire body. Many systemic diseases manifest their initial signs within the oral cavity, presenting an opportunity for early detection and intervention. This unique role of the oral cavity as a harbinger of systemic health cannot be understated.

As systemic diseases infiltrate the body, they often leave distinct markers on the oral mucosa, tongue, gingiva, dentition, periodontium, salivary glands, facial skeleton, extraoral skin, and related structures.1 To ensure patients receive the appropriate diagnosis and timely referral for treatment, it is imperative to recognize these oral manifestations accurately. In numerous instances, the oral cues serve as the earliest evidence of an underlying systemic disorder. For example, the well-documented Koplik's spots in the buccal mucosa prelude the characteristic skin rash of measles. In other cases, oral symptoms and signs closely parallel systemic complaints and clues, as seen in conditions like lupus erythematosus.2 Additionally, there are situations where oral reflections lag behind other systemic evidence, such as pemphigus, where skin eruptions precede oral ulcers.

The oral cavity's significance as a diagnostic area is multifaceted. It not only contains derivatives of all primary germinal layers but also encompasses tissues that are not visible elsewhere in the body. More importantly, it plays a pivotal role in diagnosing numerous systemic diseases due to their oral manifestations. Thus, it can be aptly regarded as a "window to the body," offering glimpses into underlying health conditions.3By recognizing these oral manifestations and understanding their radiological correlates, healthcare professionals can enhance their ability to detect and manage systemic diseases at an early stage. This review aims to shed light on the critical role of radiological imaging in this process, underlining the importance of interdisciplinary collaboration between dentists and radiologists for comprehensive patient care.

2. CLASSIFICATION:

{Table 1}

Endocrine Disorders	**Hematological Disorders**	**Bone Disorders**	**Neoplastic Disorders**
Diabetes Mellitus (Type 1 and Type 2)	Sickle Cell Anemia	Osteoporosis	Multiple Myeloma
Hyperthyroidism	Thalassemia	Osteopetrosis	
Hypothyroidism	**Infectious Diseases**	Rickets	
Hyperparathyroidism	Tuberculosis	Hypophosphatemic Rickets	
Hypoparathyroidism	Syphilis	Paget's Disease	
Hypophosphatemia	**Renal Disorders**	**Connective Tissue Disorders**	
Hypophosphatasia	Renal Osteodystrophy	Scleroderma	

{Table-1}

2.1. ENDOCRINE DISORDERS

2.1.1. DIABETES MELLITUS

Diabetes mellitus is a prevalent metabolic disorder characterized by abnormalities in carbohydrate metabolism, primarily stemming from either insufficient insulin production (Type-1 diabetes) or resistance to insulin's effects (Type-2 diabetes). In a study involving 359 subjects aged 15 to 57, panoramic radiographs were employed to assess interproximal bone levels. Their bone scores were evaluated, and factors such as age, calculus, time to follow-up, and initial bone score were considered. The study revealed that poorly controlled Type-2 diabetes was associated with a significantly higher risk of alveolar bone loss compared to those without diabetes. Another study aimed to investigate the prevalence of atheromas in patients with Type-2 diabetes, as these individuals are at a heightened risk of experiencing strokes due to factors like hyperglycemia.4 Panoramic radiographs and medical records of asymptomatic patients with Type-2 diabetes were examined. It was found that both non-insulin-treated (NIT) and insulin-treated (IT) patients exhibited a high prevalence of atheromas on their radiographs, regardless of their treatment modality. This highlights the importance of carefully reviewing panoramic radiographs for atheroma evidence in patients with Type-2 diabetes, as managing atherogenic risk factors and removing atheromas can reduce the risk of stroke. Panoramic radiographs were used to study the relationship between severe periodontal bone loss and carotid artery plaque thickness. The research found that severe periodontal bone loss was independently associated with carotid atherosclerosis, emphasizing the potential of panoramic oral radiographs as a practical tool to assess CP in atherosclerosis risk studies.5

2.1.2. HYPERPITUITARISM AND HYPOPITUITARISM

Hyperpituitarism is a condition characterized by the excessive functioning of the anterior lobe of the pituitary gland, leading to increased production of growth hormones. Radiographic features associated with hyperpituitarism include the enlargement of the jaws, particularly the mandible. This results in the lengthening of dental arches, leading to tooth spacing. Additionally, in cases of acromegaly (a type of hyperpituitarism), the angle between the ramus and body of the mandible may increase. The thickness and height of alveolar processes in the jaw may also increase. In acromegalic patients, the palatal vault may become flattened due to downward growth. The size of tooth crowns is usually normal, but the roots of posterior teeth often enlarge because of hypercementosis.6 While permanent teeth typically have normal shapes, about 50% of cases exhibit macrodontia (enlarged teeth). In some instances, the growth at the condyle exceeds that of the alveolar processes, resulting in a greater increase in the vertical depth of the ramus compared to the body of the jaw. Consequently, the upper and lower teeth may fail to come into proper occlusion.

On the other hand, hypopituitarism occurs due to reduced secretion of pituitary hormones. Radiographic features associated with hypopituitarism include the small size of the maxilla and mandible, leading to overcrowding of teeth in these bones. Permanent teeth may be retained in the maxillary and mandibular shafts. While the crowns of permanent teeth have normal size and shape, root formation is often incomplete, and the apical foramen and pulp chamber are wider than normal.7

2.1.3. HYPERTHYROIDISM AND HYPOTHYROIDISM

Hyperthyroidism, known as thyrotoxicosis, is characterized by the thyroid gland's excessive production of thyroid hormones, resulting in an elevated thyroid hormone level in the body. Radiographically, this condition may manifest as generalized osteoporosis, leading to a widespread reduction in bone density, which can be visualized in radiographs.

Conversely, hypothyroidism typically arises due to the insufficient secretion of thyroid hormones by the thyroid glands, even in the presence of thyroid-stimulating hormone (TSH). Radiographic features associated with hypothyroidism encompass various aspects. These include a widened maxilla (upper jaw), shortening of the base of the skull, retraction of the bridge of the nose, an underdeveloped mandible (lower jaw), and signs of hypocalcification in the jaws, indicating reduced calcium content. Additionally, individuals with hypothyroidism may exhibit shorter tooth roots, thinning of the lamina dura (a radiopaque line surrounding tooth roots), external root resorption, and alveolar bone resorption in adults with myxedema, a severe form of hypothyroidism. These radiographic findings serve as valuable diagnostic and assessment tools for individuals with hypothyroidism, aiding in the evaluation of this thyroid-related condition.8

2.1.4. HYPERPARATHYROIDISM AND HYPOPARATHYROIDISM

Hyperparathyroidism, first identified as a bone disease in 1891 by Von Recklinghausen, has since been recognized as a condition associated with parathyroid gland dysfunction. Radiographically, hyperparathyroidism often leads to osteoporosis in the jaws, with notable features including demineralization and thinning of cortical boundaries, particularly in areas such as the inferior border, mandibular canal, and the cortical outline of the maxillary sinuses. Additionally, changes in the normal trabecular pattern result in a "ground glass" appearance, characterized by numerous small, randomly oriented trabeculae. Another manifestation is the presence of one or multiple cysts in the jaws, presenting with well-defined margins but lacking cortical borders at the periphery. As the disease progresses, other bony lesions may develop, including brown tumors of hyperparathyroidism, named for their brown color due to hemorrhage and hemosiderin deposition. Radiographically, these tumors appear as unilocular or multilocular radiolucencies with variably defined margins and the potential for cortical expansion. Long-standing brown tumors can progress to osteitis fibrosa cystica, marked by central degeneration and fibrosis within the tumor. This condition has been colloquially referred to as "rubber jaw" because the jaw shape can be molded with fingers but returns to its original position upon release. Dental changes associated with hyperparathyroidism include the loss of crypt wall, advanced eruption relative to root development, pointed and tapered roots, particularly at the apical third, and abnormally enlarged pulp chambers. Periapical radiographs reveal the loss of the lamina dura, a radiopaque line surrounding tooth roots.

In contrast, hypoparathyroidism results from decreased parathyroid hormone secretion, leading to hypocalcemia. Radiographically, the maxilla and mandible may become abnormally dense despite lowered serum calcium levels, with increased trabeculae giving an unusually well-calcified appearance. Teeth may exhibit enamel hypoplasia, characterized by irregular and malformed crowns, with radiographic features such as spot-like radiolucencies and horizontal bands of decreased density. Additionally, dilacerations of root and external root resorption may occur in individuals with hypoparathyroidism.9

2.1.5. HYPOPHOSPHATASIA

Hypophosphatasia, first recognized as a distinct disorder by Rathbun in 1948, is a rare inherited disease caused by either reduced production or defective function of alkaline phosphatase, an enzyme crucial for normal mineralization of osteoid. Radiographically, individuals with hypophosphatasia exhibit a generalized radiolucency in both the mandible and maxilla. The cortical bone and lamina dura, which is the radiopaque lining around tooth roots, are thin, and the alveolar bone may appear poorly calcified or deficient. Both primary and permanent teeth typically have a thin enamel layer, large pulp chambers, and root canals. Crowns may appear small and bulbous, reaching the cervical area, often showing cervical constriction.10

2.2. HEMATOLOGICAL DISORDERS

2.2.1. SICKLE CELL ANEMIA AND THALASSEMIA

Sickle cell anemia (SCA) is an inherited hemolytic anemia that predominantly affects individuals of African descent. In SCA, there is a substitution of valine for the usual glutamic acid in the sixth position of the beta chain of hemoglobin. This abnormal hemoglobin tends to cause the red blood cells (RBCs) to take on a characteristic sickle shape under conditions of low oxygen, leading to reduced oxygen-carrying capacity and a higher rate of rupture compared to normal RBCs. Thalassemia, also known as Mediterranean or Cooley's anemia, is another hereditary chronic anemia resulting from a defect in hemoglobin production.11 Thalassemia is categorized into two forms: thalassemia minor (heterozygous) and thalassemia major (homozygous). Radiographic findings associated with SCA and thalassemia are primarily a result of RBC hemolysis and the compensatory increase in bone marrow activity, leading to specific bone changes. These changes include widening of the medullary spaces (osteoporosis), fewer but thicker trabeculae, and thinning of the bone cortices. In SCA, the remaining trabeculae often appear to align horizontally in an interlocking "stepladder" pattern in certain areas of the bone. However, it's worth noting that this trabeculation pattern can also be observed in individuals without SCA. SCA may also present complications such as osteomyelitis if an infection develops in a region with reduced blood flow. Thalassemia, on the other hand, causes marrow hyperplasia in facial bones, which can disrupt normal facial development. This can result in distinct facial deformities, including a protruded premaxilla and cheekbones, giving rise to a "chipmunk" face appearance. Additionally, thalassemia can lead to the absence of certain paranasal sinuses, except for the ethmoid air cells, which lack red marrow. Both SCA and thalassemia can affect dental health, leading to the presence of short and pointed tooth roots. In severe cases of these conditions, the loss of the outer layer of the skull (calvarium) can result in perpendicular trabeculae radiating outward from the inner layer of the skull in response to increased intracranial pressure, creating a distinctive "hair-on-end" radiographic appearance. The trabecular pattern is characterized by the apparent coarsening of the some trabeculae and the blurring and disappearance of others resulting in salt and pepper effect.12

2.3. INFECTIOUS DISEASES

2.3. 1.TUBERCULOSIS

Tuberculosis is a specific infectious disease caused by the acid-fast bacillus Mycobacterium tuberculosis, with the vast majority of cases originating as pulmonary infections. The oral tissues can become affected either through direct inoculation, extension from other infection sites, or via the bloodstream. Patients with tuberculosis-related jawbone lesions typically experience recurrent "toothache-like" pain and often exhibit swelling in the affected area. As these swellings rupture, sinus tracts may form, which can drain either inside the mouth or externally. Trismus, or limited jaw movement, may be present, particularly if the temporomandibular joint is affected. Jaw can manifest as areas of bone rarefaction with poorly defined borders. Periosteal new bone

formation may also occur, and there's a possibility of sequestration of necrotic bone. In addition to tuberculous osteomyelitis, panoramic radiographs might reveal calcified lymph nodes in the upper cervical region resulting from tuberculosis infection.13

2.3.2. SYPHILIS

Syphilis is an infectious disease caused by the spirochete bacterium Treponema pallidum. Bone involvement can occur in congenital syphilis and during both the secondary and tertiary stages of acquired syphilis. Although jaw involvement in syphilis is relatively uncommon, when it does occur, it tends to affect the palate more frequently than the mandible. Radiographic signs of bone involvement in syphilis encompass the deposition of new bone beneath the periosteum along the lower border of the mandible (known as syphilitic periostitis), gummatous bone destruction—particularly in the palate—resulting in large radiolucent areas, well-defined destruction along a cortical margin, or multiple radiolucent areas with poorly defined borders and the possibility of bone sequestration (syphilitic osteomyelitis).13

2.4. BONE DISORDERS

2.4.1. OSTEOPOROSIS

Osteoporosis is a systemic metabolic bone disease characterized by low bone mineral density (BMD), deterioration of cancellous bone microarchitecture, and changes in bone physical properties, resulting in increased bone fragility and fracture risk. Panoramic radiographs have been studied as potential tools for identifying individuals at risk of osteoporosis. Certain radiographic features can be indicative of osteoporosis, including generalized osteopenia, thinning and accentuation of bone cortices, and alterations in primary and secondary trabeculation. These features can help in early detection and referral for further evaluation. However, there is some debate regarding the reliability of panoramic radiographs as a screening tool for osteoporosis. The accuracy of panoramic radiographs in identifying osteoporotic individuals may vary, and additional confirmatory tests such as dual-energy X-ray absorptiometry (DEXA) are typically required for a definitive diagnosis of osteoporosis. Osteoporosis appears on radiographs as a widespread decrease in bone density and thinning of the cortical bone in the jaw, with the mandible being particularly affected .This condition results in a reduction in the number of trabeculae in the cancellous (spongy) part of the bone.14,15

2.4.2. PAGET'S DISEASE

Paget's disease of bone, also known as osteitis deformans, is a chronic condition characterized by irregular episodes of bone resorption (breakdown) and deposition (formation). This leads to the development of new bone that is structurally weak, increasing the risk of fractures. The incidence of Paget's disease rises with age and is more common in men than women, with a ratio of 2:1. Typically, it affects bones like the skull, spine, limbs, and maxilla. While the jaws are involved in only about 20% of cases, the maxilla is more frequently affected than the mandible, with a ratio of 3:1. Radiographically, the appearance of Paget's disease varies depending on the stage. In the early stage, affected bones show reduced density, particularly in the skull, where it is referred to as "osteoporosis circumscripta." Lytic lesions, characterized by circumscribed areas of reduced density, often begin in the outer cranial table. In some cases, involvement of the cranial base can result in platybasia, an abnormal flattening of the skull base, giving it a characteristic appearance called a "Tam O'Shanter" skull. As the disease progresses, there is a biphasic stage where pagetoid bone randomly fills the lytic spaces, creating patchy radiopacities described as a "cotton-wool" appearance. When the maxilla, malar bones, and frontal bones are involved, it can produce a leonine appearance referred to as "leontiasis ossea." With further advancement, bone deposition surpasses resorption, and lamina dura around the teeth in affected regions may be absent. Teeth, especially premolars, often exhibit hypercementosis.15

2.4.3. OSTEOPETROSIS

Osteopetrosis, also known as Marble Bone Disease or Albers-Schönberg Disease, is an inherited skeletal condition characterized by increased bone radiodensity. Radiographically, the increased radiopacity of the jaws may be so pronounced that the internal structure and even the roots of the teeth may not be visible in X-ray images. The heightened bone density and relatively poor vascularity increase the susceptibility of the mandible to osteomyelitis, often arising from odontogenic inflammatory lesions. The lamina dura (the radiopaque lining around tooth roots) and cortical borders may appear thicker than normal.16

2.4.4. RICKETS AND HYPOPHOSPHATEMIC RICKETS

Rickets is a condition characterized by defective mineralization of cartilage in the epiphyseal growth plate, which leads to the widening of the long ends of bones, growth retardation, and skeletal deformities, typically seen in children. From a radiographic perspective, rickets can manifest in the jaw structures. Cortical elements of the jaws, such as the inferior mandibular border or the walls of the mandibular canal, may appear thin. Inside the cancellous (spongy) part of the jaws, the trabeculae, which are the bony structures that make up the spongy bone, may show reduced density, number, and thickness. In severe cases, the jaws may appear highly radiolucent, making it seem like the teeth lack proper bony support. Osteomalacia, a related condition, typically doesn't produce significant radiographic findings in the jaws. However, when present, it may lead to an overall radiolucent appearance and sparse trabeculae. Hypophosphatemic Rickets, first described by Albright et al. in 1937, is a syndrome characterized by marked hypophosphatemia (low phosphate levels), short stature, and rickets. Hypophosphatemia represents a group of inherited conditions that lead to renal tubular disorders, causing

excessive phosphorus loss. Proper bone calcification requires the correct balance of serum calcium and phosphorus. Radiographically, the jaws in individuals with hypophosphatemic rickets typically exhibit osteoporosis, and in severe cases, they can appear remarkably radiolucent. Cortical boundaries may be unusually radiolucent or even absent. Other possible radiographic features include a reduced number of visible trabeculae and a granular trabecular pattern. The normal cortical layer of bone around developing tooth follicles may be missing, giving the impression that the teeth lack solid support. The lamina dura (the radiopaque lining around tooth roots) may become sparse, and cortical boundaries around tooth crypts may be thin or entirely absent. Additionally, taurodontism (an atypical tooth shape) in the first and second permanent molars has been reported in many male patients with this condition.17

2.5. RENAL DISORDERS

2.5.1. RENAL OSTEODYSTROPHY

Renal osteodystrophy refers to skeletal changes resulting from chronic renal disease, driven by disorders in calcium and phosphorous metabolism, abnormal vitamin D metabolism, and increased parathyroid activity. Radiographically, the density of the mandible and maxilla in renal osteodystrophy may be either less than normal or occasionally greater than normal. Manifestations include loss of trabeculation, a ground glass appearance, giant cell lesions or brown tumors, and metastatic calcification. The compact bone of the jaws may become thinned, eventually leading to the loss of important landmarks, such as the lower border of the mandible, the cortical margins of the inferior dental canal, the floor of the maxillary sinus, and the loss of lamina dura around teeth. In cases of significant decalcification, teeth may appear more radiopaque. The lamina dura may be absent or less apparent when bone sclerosis is present. Periapical radiolucencies and root resorption can be associated with the gradual loosening of the dentition.18

2.6. CONNECTIVE TISSUE DISORDER

2.6.1. HIDEBOUND DISEASE

Progressive systemic sclerosis, also known as scleroderma, dermatosclerosis, or hidebound disease, is a generalized connective tissue disorder characterized by excessive collagen deposition, leading to the hardening (sclerosis) of the skin and other tissues. Radiographically, progressive systemic sclerosis can exhibit distinctive features in the mandible. There is an unusual pattern of mandibular resorption observed at sites of muscle attachment, including the ascending ramus, condyle, mandibular angle, coronoid process, and antegonial notch. This resorption occurs due to the tightening of the skin in the affected areas, exerting pressure on the underlying bone. Additionally, there may be an increase in the width of the periodontal ligament spaces around the teeth. This widening of the periodontal ligament spaces is attributed to increased collagen synthesis within the ligament itself, leading to an enlargement of the ligament's bulk. This expansion occurs at the expense of the alveolar bone, resulting in the observed increase in the width of the periodontal ligament space. Importantly, the lamina dura, the radiopaque lining around tooth roots, typically remains unaffected in this condition.[19]

2.7. NEOPLASTIC DISORDER

2.7.1. MULTIPLE MYELOMA

Multiple myeloma is a type of neoplastic (related to the growth of tumors) proliferation of plasma cells that can manifest in various forms. From a radiographic perspective, multiple myeloma is characterized by distinct, non-corticated lytic lesions in the bones, which appear as "punched-out" lesions. These lesions can vary in size, ranging from a few millimeters to several centimeters. About one-third of multiple myeloma patients may exhibit these lesions in the mandible, and they can sometimes be the initial bony signs of the disease. In some cases, these lesions may coalesce, giving the impression of multilocular cavities. Additionally, generalized osteopenia (reduced bone density) and cortical effacement, particularly in the spine and pelvis, are common radiographic features of multiple myeloma.20

3. CONCLUSION

The early detection and management of systemic diseases through the identification of oral manifestations are vital for improving patient outcomes. Radiological imaging techniques play a pivotal role in achieving this goal. This review article highlights the significance of radiological imaging in understanding and diagnosing oral manifestations of systemic diseases, emphasizing the importance of interdisciplinary collaboration between radiologists and dentists for comprehensive patient care.

4. Conflict of interest:

The author’s declare no conflict of interest

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