Radiopacities in soft tissue on dental radiographs: diagnostic considerations

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SUMMARY

Radiopacities in soft tissue in the maxillofacial and oral region frequently manifest on panoramic radiographs in various locations and in several sizes and shapes. Accurate diagnosis is important as the finding may indicate serious disease states. This manuscript provides guidelines for the interpretation of soft tissue radiopacities seen on dental radiographs and recommends additional radiological views required to locate and diagnose the calcifications.

INTRODUCTION

Soft tissue radiopacities include calcification, ossification or foreign objects. The latter are excluded from this manuscript. Calcification is the deposition of calcium salts in tissue. The pathogenesis is based on either dystrophic or metastatic mechanisms. *Dystrophic calcification*, which comprises the majority of soft tissue calcifications in the head and neck region, is the result of soft tissue damage with tissue degeneration and necrosis which attracts the precipitation of calcium salts. The blood calcium concentration in these patients is normal. Appropriate examples are calcification of a focus of necrosis of tuberculosis, necrotic tumour tissue or of atheromatous plaque.

Metastatic calcification on the other hand results from the deposition of calcium salts in normal tissue in the presence of hypercalcemia secondary to metabolic causes such as hyperparathyroidism and skeletal deposits of malignant disease. Metastatic calcifications are therefore generally spread more widely throughout the body than dystrophic calcifications which tend to be more localized. The radiology literature is ambiguous in distinguishing between soft tissue calcification and ossification as the distinction can often only be made histologically. Soft tissue ossification is the formation of mature bone with or without bone marrow in an extra-skeletal site. Appropriate examples are elongation of the styloid process through ossification of the attached ligaments and bone formation in synovial chondromatosis.

Idiopathic calcification involves normal serum calcium concentration and healthy tissue, and can as such not be classified as either dystrophic or metastatic. Examples of this are tumorous calcinosis which presents with calcifications around joints and calcinosis cutis, which manifests in the cutaneous or subcutaneous tissue overlying the jaw bones. The latter two conditions are rare and will not be discussed further.

Dental practitioners are required to identify, diagnose, treat or refer for treatment all pathology identified on a radiograph. This paper is aimed at providing practitioners with insight into the differential diagnosis of soft tissue radiopacities seen on dental radiographs. In order to achieve this, a thorough knowledge of the anatomic structures in the head and neck area is important. Accurate interpretation relies on correct positioning of the head during radiographic examinations as this may influence the location and visibility of soft tissue radiopacities on the radiograph. Most calcifications require no further management, but there are several which, if not identified and managed appropriately, could have serious health consequences.

ACRONYMS

CAC: calcified carotid plaque
CBCT: cone beam computed tomography
CTC: calcified triticeous cartilage
GHH: greater horn of hyoid bone
SHTC: superior horn of thyroid cartilage

PARAMETERS FACILITATING ACCURATE INTERPRETATION

When radiopacities present as an incidental finding in a soft tissue site, it is of pivotal importance to perform a thorough clinical examination which includes history taking and palpation of the respective site. The anatomical position, number of radiopacities, shape- and size of the calcifications and their internal structure provide important guidelines for their accurate interpretation (Table 1).

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Table 1: Location on radiographs and description of soft tissue radiopacities

Diagnosis	Location on radiographs	Periphery, shape and number of lesions	Internal structure
Elongated styloid process and ossified stylohyoid ligament	Between posterior ramus and cervical spine , next to- or crossing angle of mandible, below and mesial from the angle (Figure 1)	Tapering, slender, regular, linear and longer than 3 cm,[1] radiopaque outline	Radiopaque or outlines more radiopaque, may be segmented
Calcified lymph nodes	Submental, submandibular and cervical (Figure 2)	Irregular, lobulated, cauliflower-like,[3] single or multiple, vary in size	Varying degrees of opacity[3]
Carotid artery calcification (CAC)	Postero-inferior to mandibular angle,[17] adjacent to the cervical vertebrae, at or close to intervertebral space C3-C4[19] (Figure 3)	Irregular, nodular mass or masses, curvy- or roughly verticolinear,[9,22] irregular radiopaque line (s),[17] rectangular[17]	Radiopaque
Sialoliths (Salivary stones)	1. Submandibular sialoliths: on or below body- and mesial to angle of mandible, above hyoid bone (Figure 4 and 5) or on apices of mandibular premolars 2. Parotid sialoliths: on upper third of ramus or anterior or posterior of it (Figure 1)	1. Regular but may be irregular if close to hilus of gland, smooth, round or oval, single or multiple 2. Small, round or oval, single or multiple	Radiopaque, frequently laminated or stippled according to degree of calcification Radiopaque
Tonsilloliths (calcified tonsils)	Mid-portion of ramus[12] where dorsum of tongue crosses the ramus and angle, often below the inferior alveolar canal (Figure 6)	Well-defined, round to oval, irregular, small and multiple (cluster) or single and larger (rare)	Radiopaque, cortical density
Myositis Ossificans	Anatomic region of muscle (s) of mastication (Figure 7)	Localized or generalized	Radiopaque
Synovial osteochondromatosis, Tumoral calcinosis	Associated with TMJ[13] (Figure 8) In soft tissue around mandibular condyle[15]	Large, globular, single or multiple	Radiopaque
Calcification of superior horn of thyroid cartilage (SHTC)	Below the terminal portion of greater horn of hyoid bone (GHH)[9] ,(Figure 9) and mesial to C3 and/or C4.	Elongated, regular process, cord-like, radiopaque outline may be visible, one each side	Radiopaque or outlines more radiopaque
Calcified triticeous cartilage (CTC)	Between SHTC and GHH, level of C3 and C4[17] (Figure 9), 2-4 mm wide and 7-9 mm in length[16]	Well-defined, smooth, oval,[16,17] resembles a grain, one each side	Radiopaque or outlines more radiopaque
Antrolith	Most frequently above floor of maxillary sinus (Figure 10)	Well-defined, smooth or irregular, single	Radiopaque, laminated
Rhinolith	Nasal cavity	Well-defined, smooth or irregular, single	Radiopaque, sometimes laminated

Although most radiopacities are asymptomatic, symptoms may be helpful in establishing a diagnosis. The stylohyoid process arises from the inferior surface of the temporal bone and extends infero-mesially towards the pharyngeal wall. Two ligaments (stylohyoid and stylomandibular) and three muscles (stylohyoid, stylopharyngeus and styloglossus) originate from this process and together they are sometimes called the "stylohyoid chain". Ossification of one or more of the components of the chain begins normally at the styloid process and can create the radiographic image of an elongated styloid process. The stylohyoid ligament is attached at the lesser horn of the hyoid bone and therefore stabilizes it. Patients with an ossified **stylohyoid ligament** may manifest with headaches, pain with swallowing, yawning and with moving the head laterally, referred temporomandibular joint (TMJ) pain or recurrent throat pain due to impingement of the elongated process on adjacent structures.[1,2] A symptomatic ossified stylohyoid ligament is referred to as Eagle syndrome and panoramic radiography showing a length of 3cm or more is sufficient to confirm the diagnosis (Figure 1).

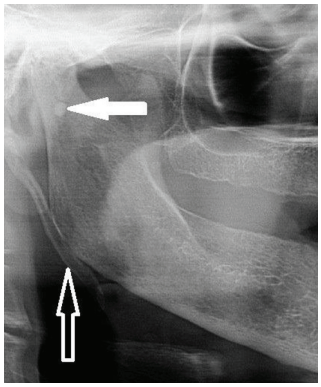

Figure 1: Panoramic image (cropped). The radiopaque outlines of an ossified stylohyoid ligament (open arrow), passing the angle of the mandible, are present in this radiograph of a 77-year-old female. A calcification within Stensen's duct of the parotid gland can also be seen projecting onto the upper part of the ramus (solid arrow).

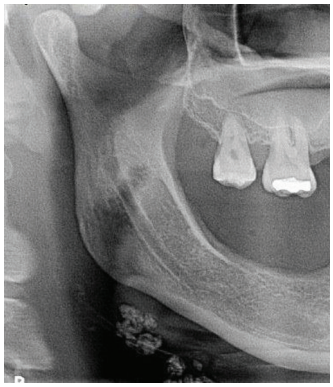

Figure 2: Panoramic image (cropped). Several calcified lymph nodes present as irregular shaped radiopacities below the lower border of the right mandible.

A productive cough or history of tuberculosis may be an indication of tuberculous lymphadenitis with **dystrophic calcification of lymph nodes.**[3-5] Calcified lymph nodes are asymptomatic (unless secondarily infected) and may be seen as an incidental finding on a panoramic radiograph at the anatomic sites where lymph nodes are found

(Figure 2).[4,5] The patient should be informed of the possible implications and referred for follow-up care to exclude active tuberculosis or other serious underlying diseases which could manifest with such calcifications.

Tinnitus or an affirmative history of a stroke, transient ischemic attacks[6] or temporary loss of vision (ocular ischemia) may result from stenosis of the carotid artery due to **atheromatous plaque**, which is often heavily calcified (calcified carotid plaque or CAC, Figure 3). Calcifications in the walls of other arteries (e.g. facial artery) are site-specific and knowledge of the vascular anatomy is required for correct interpretation. In asymptomatic patients early recognition and appropriate referral of patients with CAC reduces morbidity and mortality by preventing vascular obstruction, which has the potential to result in cerebrovascular incidents, coronary heart disease and loss of vision.[6-11] CAC and calcified cervical lymph nodes present with overlapping features and may be difficult to differentiate.

Another cause for dystrophic calcification in lymph nodes is **necrotic metastatic malignant deposit** which frequently occurs post chemo- or radio therapy. Swelling and pain upon salivation mainly during meals may prompt a clinical diagnosis of chronic submandibular sialadenitis due to the presence of one or more calcified submandibular sialoliths which obstruct the flow of saliva (Figures 4 and 5).

Tonsilloliths develop due to chronic inflammation of the tonsils. If large, they protrude from the tonsillar crypts and manifest clinically as yellow or white stones. Symptoms such as tonsillar swelling, pain, difficulty in swallowing, the sensation of a foreign object in the throat[12] and halitosis may be present. A clinical diagnosis supported by multiple small radiopacities superimposed on the mid-ramus and angle of the mandible on a panoramic view is sufficient for the diagnosis of tonsilloliths (Figure 6). If uncertain, CBCT examination can be performed which will confirm the location in the tonsillar bed.

Myositis Ossificans is dystrophic calcification within a muscle and is induced by trauma and haemorrhage and can be localized when affecting only one muscle or generalized, affecting several muscles. The muscles of mastication can be involved and the condition is therefore seen in their anatomical locations (Figure 7).

Synovial osteochondromatosis[13] and **tumoral calcinosis**[14,15] are rare disorders which more commonly affect major joints than the TMJ. Synovial osteochondromatosis is usually characterized by unilateral osteo-cartilagenous nodules in the synovium of the joint (Figure 8) and may be associated with pain and swelling, while tumoral calcinosis presents with painless nodular swelling in the soft tissue surrounding the TMJ. Some panoramic machines have special TMJ programs which facilitate the identification of radiodense deposits in and around the joint.

Calcifications of the **laryngeal cartilage** occur at an advanced age and present in the superior horn of the thyroid cartilage and the triticeous cartilage (Figure 9).[16,17] Both structures occur bilaterally in the upper neck and may be located in the vicinity of the carotid bifurcation. These must be distinguished from CAC which may occur in the same anatomical site by employing additional radiological examinations. The superior 2 to 3mm of the **superior horn of the thyroid cartilage**, when calcified, is seen on a panoramic radiograph as a cord-like soft tissue calcification with the rounded top mesial to C4 (Figure 9).[16] The **triticeous cartilages** are bilateral, well-defined single ovoid faint radiopaque structures located in the lateral thyrohyoid ligament at the level of C3 and C4 between the superior horn of the thyroid cartilage and the greater horn of the hyoid bone (Figure 9).[9,16,17] The distal portion of the **greater horn of the hyoid bone** may be misinterpreted

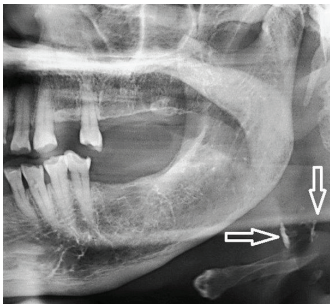

Figure 3: Panoramic image (cropped). The arrows indicate two radiopaque roughly parallel lines which are evidence of calcified carotid atheromatous plaque (CAC) in the bifurcation between the external and internal carotid arteries in this 76-year-old female.

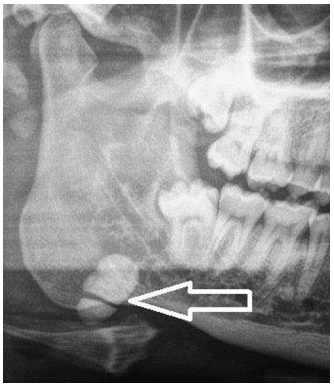

Figure 4: Panoramic radiograph (cropped) presenting a large sialolith (arrow) in the duct of the right submandibular gland.

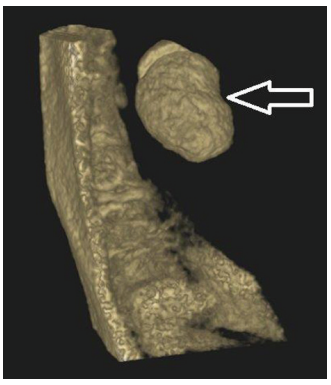

Figure 5: Axial view of a 3D CBCT image of the patient in Figure 4 illustrates the position of the sialolith in the floor of the mouth.

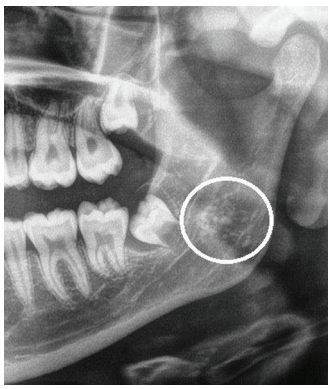

Figure 6: Panoramic radiograph (cropped). Tonsilloliths (white circle) present as a cluster of multiple small irregular radiopacities in the oropharyngeal area below the inferior alveolar canal.

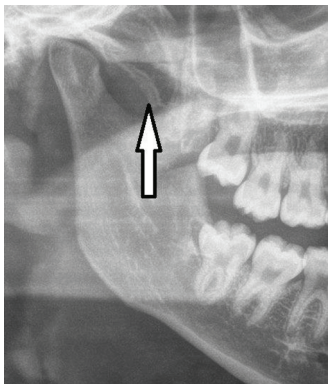

Figure 7: Panoramic image (cropped) shows myositis ossificans of the distal fibres of the temporal muscle and its tendon at its attachment at the lower part of the coronoid process.

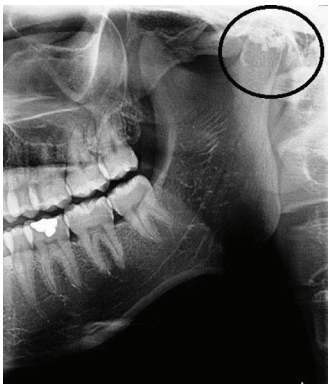

Figure 8: Irregular large calcifications associated with the left temporomandibular joint. The lesions were palpated as firm nodules in the capsule of the TMJ, surgically removed and confirmed microscopically.

as CAC as it is located in the region of the carotid bifurcation (Figure 9). **Phleboliths** are rare and associated with calcified thrombi in veins, hemangiomas or venous malformations of the oro-facial structures.[9,18] They are most frequently localized in the cheek area, rarely in the neck and occur in both children and adults. Phleboliths are randomly distributed and present as regular and spherical radiopacities with mixed density, referred to as laminated[18] or onion-like.[9] When seen on dental radiographs, they might be confused with sialoliths, tonsilloliths or intrabony lesions. Their association with a vascular anomaly or hemangioma in hard- or soft tissue is, however pathognomonic.

Calcified fibro-epithelial polyp and **calcified gingival tumours** e.g. peripheral ossifying fibroma are rare and may appear as regular or irregular oval radiopacities superimposed over the occlusal third of teeth.

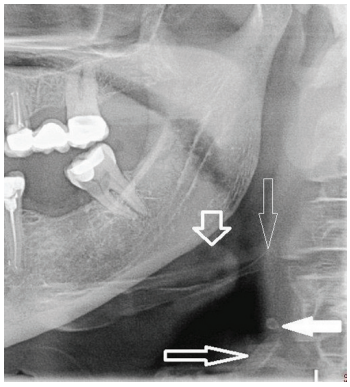

Figure 9: Panoramic image (cropped) shows the terminal portion of the greater horn of the hyoid bone (long slender open arrow), calcified triticeous cartilage (short solid arrow), calcified superior horn of the thyroid cartilage (long bold arrow) and shadow of the epiglottis (short open bold arrow).

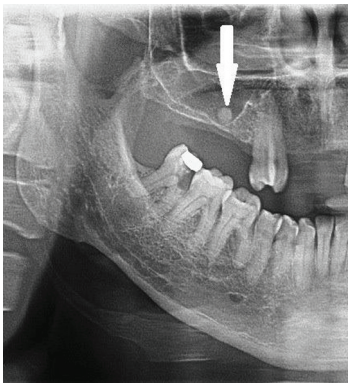

Figure 10: Panoramic image (cropped): A round radiopaque antrolith is seen above the floor of the right maxillary sinus (white circle)..

ANCILLARY RADIOGRAPHIC TECHNIQUES

A combination of clinical-and dental radiographic examinations may confirm most soft tissue radiopacities and additional radiographic techniques can be employed to locate them. On panoramic radiographs salivary stones (sialoliths) in the duct of the submandibular salivary gland may be superimposed on the body of the mandible and mimic intra-bony radiopacities. It is beyond the scope of this manuscript to discuss the conditions manifesting as radiopacities within bone, however standard occlusal- or lateral oblique radiographs, the submentovertex projection, sialography or CBCT are pivotal in confirming the location outside bone and in the soft tissue of the floor of the mouth (Figure 5). Three-dimensional CBCT is a cost-ineffective alternative to these techniques. Parotid duct calculus may be differentiated from a bony lesion in the maxilla by placing a periapical film in the buccal vestibule opposite the duct and irradiating the area while the patient blows up the cheek. The exposure dose should be less than with hard tissue to prevent "burning out" of the less calcified salivary stones.

Panoramic radiography is not considered suitable for population-level screening for carotid stenosis.[6,19] The reason is that only calcified carotid plaque is seen on panoramic radiographs and the presence of a calcification is not always indicative of non-calcified atheromatous stenosis.[6] Panoramic radiographs are, however frequently prescribed during dental care, are non-invasive, cost effective and of good reliability when calcified carotid plaque is present.[20-26] It has been reported that carotid stenosis of 50% and more is almost always calcified and detectable on panoramic radiographs.[6] The diagnosis of CAC should however be confirmed by Duplex Doppler ultrasound[11,27-29] or CBCT.[9] Angiography,[6] frontal radiography of the neck,[6] cervical spine radiography, magnetic resonance imaging and conventional computed tomography have also been used for the detection or confirmation of calcified atheromatous plaque.[24] Synovial chondromatosis, tumoral calcinosis, antroliths and rhinoliths can be confirmed by examinations like CBCT or conventional computed tomography. Although **antroliths** (Figure 10) and **rhinoliths** are easily recognized on panoramic radiographs, extraoral radiographs such as the postero-anterior skull- and the Waters projection are often helpful in confirming a suspicion of an antrolith or rhinolith respectively.

In general, incidental findings of soft tissue calcification in the neck may be life-saving especially in the case of carotid artery calcifications and tuberculosis. The dentist is advised to refer a patient with undiagnosed and possible life-threatening soft tissue calcifications in the neck for further examination.[19]

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