Radiopacities in soft tissue on dental radiographs: diagnostic considerations

SADJ March 2015, Vol 70 no 2 p53 - p59
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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 hypercalcaemia 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.

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 anatomic position, number of radiopacities, shape- and size of the calcifications and their internal structure provide important guidelines for their accurate interpretation (Table 1).

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

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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, styloglossus, and styloglossus) originate from this process and altogether 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. A symptomatic ossified stylohyoid ligament is referred to as Eagle syndrome and panoramic radiography showing a length of 3 cm or more is sufficient to confirm the diagnosis (Figure 1).

A productive cough or history of tuberculosis may be an indication of tuberculous lymphadenitis with dystrophic calcification of lymph nodes. Calcified lymph nodes are asymptomatic (unless secondarily infected) and may be seen as an incidental finding on a panoramic radiograph at the anatomical sites where lymph nodes are found.
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 radiotherapy. 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\(^2,15\) 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).\(^2,16,17\) The distal portion of the greater horn of the hyoid bone may be misinterpreted...
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.\(^\text{9,18}\) 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\(^\text{9}\) or onion-like.\(^\text{9}\) When seen on dental radiographs, they might be confused with sialoliths, tonsilloliths or intrabony lesions. Their association with a vascular anomaly or hemangiomata 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.

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.\(^\text{8,9,19}\) 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.\(^\text{6}\) Panoramic radiographs are, however frequently prescribed during dental care, are non-invasive, cost effective and of good reliability when calcified carotid plaque is present.\(^\text{20-26}\) It has been reported that carotid stenosis of 50% and more is almost always calcified and detectable on panoramic radiographs.\(^\text{6}\) The diagnosis of CAC should however be confirmed by Duplex Doppler ultrasound\(^\text{21,27-29}\) or CBCT.\(^\text{9}\) Angiography,\(^\text{9}\) frontal radiography of the neck,\(^\text{6}\) cervical spine radiography, magnetic resonance imaging and conventional computed tomography have also been used for the detection or confirmation of calcified atheromatous plaque.\(^\text{24}\) Synovial chondromatosis, tumor calcnosis, 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.\(^\text{19}\)

Declaration: No conflict of interest was declared.

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Dentistry in the 21st Century! Cape Town, 5 - 7 Nov 2015
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