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Chapter 33

Panoramic Radiography — Diagnosis of Relevant Structures That Might Compromise Oral and General Health of the Patient

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1. Introduction

The chapter provides information about panoramic radiography, showing the principal indications, advantages and disadvantages of this examination. Moreover, focus is given to some anatomical variations that can be detected on panoramic radiographs such as bifid mandibular canal, retromolar canal, and alterations such as calcified stylohyoid complex, arterial calcifications, phleboliths, sialolithiasis and tonsilloliths. Such structures/alterations are not reasons for indication of panoramic radiography, but they are radiographic findings, being important their identification, indication of more accurate examinations, and even referring to other professionals. Therefore, a literature review was conducted, citing relevant anatomy textbooks and scientific papers, and it was illustrated with panoramic radiographs showing these described structures/alterations.

2. Indications and contraindications of panoramic radiographs

Panoramic radiography is a radiologic technique that provides an overview of the jaws and surrounding structures. It is frequently indicated when professionals want to evaluate some structures such as unerupted third molars, orthodontic treatment, tooth development, developmental abnormalities, trauma, large lesions, and others [1, 2]. The panoramic radio-
The panoramic radiography is frequently used as initial diagnostic image of some alterations and based on it, the professional will verify the need of other more detailed and more accurate examinations [1].

If you have a full-mouth series, the panoramic radiography shows no more or little useful information for a patient receiving general dental care [1].

Some contraindications of panoramic radiographs are clinical situations that require detail and definition, such as carious lesions, visualization of alveolar crests, level of root canal filling [3], periodontal disease or periapical lesions [2].

In dental clinical practice, panoramic radiography is one of the most indicated radiographic examinations by dentists because it provides a general overview of dentomaxilomandibular structures and it is not so costly for patients.

3. Advantages and disadvantages of panoramic radiography

Panoramic radiography has many advantages including short time for the procedure, greater patient acceptance and cooperation, overall coverage of the dental arches and associated structures (more anatomic structures can be viewed on a panoramic film than on a complete intraoral radiograph series), simplicity, low patient radiation dose [2, 4]. The dose to the patient is approximately ten times less than full-mouth survey using the long cone and E+ film and it is four times less than four bitewings using the long round cone and E+ film [4].

The panoramic radiograph is less confusing to the patient than a series of small separate intraoral radiographs, making it easier for the dentist to explain the diagnosis and treatment plan to the patient [5].

The panoramic radiograph is an excellent imaging modality in patients with trismus or trauma, because such patients cannot open their mouths and this is not needed to take a panoramic film [4]. It is an excellent projection of diverse structures on a single film, which no other imaging system can achieve. Individual structures may be imaged by other methods, once pathologic conditions have been detected using the panoramic radiography [3, 4].

Nevertheless, this radiographic examination presents a lack of details and resolution of some structures due to overlapping of anatomical structures in the image, mild distortion and magnification [1, 3]. Objects of interest that are located outside the focal trough (it is the area of the dental anatomy that is reproduced distinctly on the panoramic radiograph) [5] are not seen [2], and artifacts are common and may easily be misinterpreted [5].

These features limit the indications of panoramic radiographs in cases where details and accurate measurements are needed [1, 3].
4. Anatomical variations observed on panoramic radiographs

The term "normal" in Anatomy refers to the shape and position most frequently found in individuals, that is, the typical shape. Anatomical variation is the deviation from the normal that does not bring any noticeable functional disorder [6].

Not very unusual, the bifid mandibular canals are observed on panoramic radiographs (Figure 1).

![Digital panoramic radiography with a bifid mandibular canal image on the left side.](image)

Figure 1. Digital panoramic radiography with a bifid mandibular canal image on the left side.

There are different frequencies and shapes in the literature.

Only 4 panoramic radiographs (0.08%) from 5,000 were highly suggestive of bifurcation [7]. Seven cases (0.35%) from 2,012 radiographs presented a suggestive image of a double mandibular canal [8]. From 700 panoramic radiographs evaluation, 3 cases (0.43%) showed bifid mandibular canal [9]. Duplication or division of the mandibular canal was found in 33 individuals (0.9%) from the 3,612 evaluated panoramic radiographs [10]. It is important to observe the presence of bifid mandibular canals to prevent potential complications during surgical dental procedures. A total of 6,000 panoramic radiographs were studied, and there were 57 bifid mandibular canals (0.95%) [11].

Three main patterns of duplication were found radiographically [10]. The first variety (Type 1) consisted of two canals originating from one foramen. The second variety of duplication or division (Type 2) was produced by a short upper canal extending to the second molar or third molar teeth. Type 3 was seen as two mandibular canals of equal dimensions apparently arising from separate foramina in the mandibular ramus and joining together to form one canal in the molar region of the body of the mandible. Other variations (Type 4) included duplication or division of the canal, apparent partial or complete absence of the canal or lack of symmetry.
The most common supplemental mandibular canals are duplicate canals commencing from a single mandibular foramen and the least common arising from two distinctly separate foramina [10]. A different classification was used by reference [9], which verified that type III (the canal is located close to the lower border of the mandible) is the most common, followed by the type II (the canal is noted between the apices of the first and second molars and the lower border of the mandible) and the type I (the canal is in close contact with the apices of the first and the second molars).

No great difference in frequency between males and females was found by reference [10] and there was no statistical significance between sex and types of the mandibular canal in the study of reference [9]. Women presented more bifid mandibular canals than men (63.5% vs. 36.5%) [8].

When bifid mandibular canals were evaluated by cone beam computed tomography (CBCT), a higher frequency was found. An incidence of 15.6% from 301 mandible sides was observed by [12] and, in a recent study an incidence of 10.2% was found in CBCT of 1933 patients [13]. However, different results were found by reference [8]. In their study, computed axial tomography was used in 3 of the 7 cases with apparent double inferior alveolar nerve images on panoramic radiographs. The existence of a bifid canal could only be confirmed in 2 of these patients. The authors suggested that the true incidence of bifid mandibular canals might be lower than reported by other studies. The possible causes underlying a false double-canal radiograph may include the imprint of the mylohyoid nerve on the internal mandibular surface where it separates from the inferior alveolar nerve and travels to the floor of the mouth [8, 14, 15]. Another explanation could be the radiologic osteocondensation image produced by the insertion of the mylohyoid muscle into the internal mandibular surface, with a distribution parallel to the dental canal [8, 16].

Bifurcation of the mandibular nerve may be a cause of inadequate anesthesia in a small percentage of cases [7, 8]. One of the seven patients who presented bifid mandibular canals on panoramic radiographs commented that her dentist had experienced problems in performing inferior alveolar nerve block in the past. Another patient had no such problems, and the remaining five patients had either never undergone anesthesia or remembered no associated problems [8]. This problem is usually resolved by performing inferior alveolar nerve anesthesia at a somewhat higher level (the so-called “Gow-Gates” technique) [8, 17]. Other possible complications can occur during surgery of the lower third molar, in orthognathic or reconstructive mandibular surgery, and in the placement of dental implants [8, 18], because of possible damage to an unidentified second mandibular canal [8].

Another anatomical variation that can be observed on panoramic radiographs is the retromolar canal, and it can be considered a type of mandibular canal division.

Retromolar canal has been observed in dry mandibles, cadaveric dissections, panoramic radiographs and cone beam computed tomography. Variability in the prevalence of the retromolar canal is also verified in different studies, 1.7% [19], 12.19% [20], 12.9% [21], 14.08% [22], 17% [23], 18% [24], 21.9% [25], 25% [26], 26.58% [27] (studies with dry mandibles); 5.8% [28], 16.8% [29] (studies with panoramic radiography); 16% [30], 75.4% in individuals assessed
According to reference [71], the panoramic radiography can be the first auxiliary in diagnosis for detecting facial artery calcification in patients in hemodialysis. The authors suggested that more studies should be performed, in order to determine the incidence of that alteration in those patients.

Radiographically, the calcium deposited in the arterial wall outlines the artery contour, being identified as a pair of parallel, thin radiopaque lines, or with circular aspect, depending on the evaluated view [1].

5.3. Sialolithiasis

Sialolithiasis is the most common disease of the salivary glands [72-74] characterized by obstruction of salivary secretion by a calculus, associated with swelling, pain [72, 75, 76] and infection of the affected gland [75]. More than 80% of the salivary gland calculus occurs in the submandibular gland [1, 72, 74-78] and 5%-20% in the parotid gland [72, 75-78] and rarely in the sublingual gland and the minor salivary glands (1% to 2%) [72, 75-77]. It is common in adults (1.2% of the population), with a male predominance [1, 72, 74, 76, 77], although previous investigators cited that sialolithisis occurs more frequently in white woman [73]. Children are rarely involved and sialolithiasis is more frequently in the third to the sixth decades of life [72, 74-77].

Patients with sialolithiasis may complain of moderate to intense pain when it involves the duct of a major salivary gland, particularly at mealtimes, when salivary flow is stimulated [1, 73], associated with enlargement of the gland [73].

Sialoliths are stones found within the ducts of salivary glands [1] and may be single or multiple [72, 76]. Single sialolith is more common seen [1, 79]. Figure 8 shows a panoramic radiography with a single sialolith on the right side in the submandibular gland. They measure from 1 mm to less than 1 cm [72, 74, 75]. Gigant sialoliths are rare, bigger than 3.5 cm and also occur in male patients and are commonly located in the submandibular gland [74].

According to reference [74], several factors seem to be involved in the development of salivary calculi in the submandibular gland tissues such as: the submandibular excretory duct is wider in diameter and longer than the Stensen’s duct; the secretion against gravity [74, 77]; the secretion is more alkaline compared with pH of the parotid saliva; the submandibular saliva contains a higher quantity of mucin proteins, while parotid saliva is entirely serous; then its saliva presents high calcium and phosphate content [73, 74, 77].

Initial events that contribute for the formation of a nidus that later will be the site for the precipitation of mineral salts contained in the salivary secretion include infection, inflammation, physical trauma, salivary stagnation, introduction of foreign bodies and the presence of desquamated epithelial cells [73, 74].

The likely mechanism of sialolith formation in the sublingual gland is mechanical trauma with mucus extravasation, which serves as a nidus for stone formation [77]. In summary, the formation of a sialolith requires salivary stagnation, a nidus and a precipitation of salivary salts [75].
Depending on the sialolith size and calcification degree, it can be visible in conventional radiographs. In panoramic radiography, the calcification image may appear superimposed on the mandible; therefore, it may be mistaken by an intrabone lesion [73]. Plain film radiography demonstrates dystrophic calcifications and the possible involvement of adjacent osseous structures [1].

Panoramic radiography usually shows sialoliths in the submandibular gland if they are located in the posterior duct [1]. If calculi can not be visualized in conventional radiographs, other imaging examinations may be necessary [73]. Sialography is used to evaluate obstructive and inflammatory conditions of the ductal system. If the patient is allergic to the iodine contrast agent used in sialography, the alternative imaging examination is ultrasonography or scintigraphy [1].

Computed tomography or magnetic resonance imaging are appropriate if the sialography suggests the presence of a space-occupying mass [1]. According to previous investigation, panoramic radiography and CT scan estimation appeared to be somewhat closer to the surgical specimen size [75].

Sialoliths in the sublingual gland are usually round or oval shaped. However, stones in Wharton’s duct may be elongated. Parotid stones are usually smaller and more often multiple [77]. A single mass of calcification of the parotid gland with a calcification of part of its duct can be seen in the Figure 9.

Giant sublingual sialolith was previous described as a large single calcified mass in sublingual area on panoramic radiography. Giant sublingual sialolith has already been associated with dysphagia as well as eating and speaking difficulty [76].

Sialolith is usually homogeneously radiopaque, although it can show evidence of multiple layers of calcification if large [1, 79]. Salivary stones are usually shaped by the duct and then
they are elongated [77, 79]. Sialoliths are more likely localized in the Wharton’s duct (submandibular gland) than in the Stensen’s duct (parotid gland) [79]. Figure 10 shows calcifications in the submandibular and parotid glands.

A previous report described 3 cases with multiple microliths in their parotid parenchyma in Sjögren’s syndrome showing panoramic radiography with many spots-like calcifications observed around the gonial angle and in the posterior part of the ramus [78]. According to
found within vascular channels, often in the presence of hemangiomas or vascular malformations. They may originate from injury to a vessel wall or result from stagnation of the flow of blood [83, 84]. A case of intramuscular hemangioma was related by reference [85], where it was observed the large number of phleboliths of the tongue due to the long-term presence of hemangioma and stagnant blood flow. The authors [86], when reporting an intramuscular hemangioma also suggested that the cause of the large number of phleboliths is the long-term presence of hemangioma and stagnant blood.

The presence of vascular anomalies in the head and neck has a great importance for the professionals working in this area, since any procedure performed in this region without the due caution may trigger the onset of an emergency, as bleeding, which can lead to the patient's death. Therefore, there is a need to conduct a thorough diagnosis in order to help in the discovery of the existence of these defects, so that such situations are avoided [87]. Those authors reviewed the charts of 108 patients with vascular anomalies and observed in 31% of the cases that the changes were in the region of the mouth and tongue, being the period of childhood and adolescence the most affected (64%).

Clinically, the vascular changes may have a swollen soft tissue, which is throbbing and with its modified coloration and some noises when auscultating [1].

A case of a patient with multiple swellings on the surface and in the mouth with a purplish coloration in intraoral examination was reported by reference [88]. Radiographic examination showed small phleboliths in the left submandibular region, and ultrasound also showed calcifications. Histological examination showed that the characteristics are originated from venous malformation. Three cases of hemangioma of the head and neck varying like the clinical characteristics presented were presented by reference [89], however some commonalities between them could be noticed as swelling, absence of pulse or noise, and two cases showed discoloration.

Phleboliths calcification starts in the center of the thrombus and consists of apatite crystals of calcium phosphate and carbonate [1]. Initially, calcification of the thrombus occurs, forming the core of the phlebolith. The fibrinous component then undergoes secondary calcification and becomes attached. Repetition of this process causes enlargement of the phlebolith [86].

Radiographically, the phlebolith features radiopaque, rounded or oval image measuring more than 6mm in diameter and uniform periphery. Internally, it can present a homogeneous radiopacity, but it commonly presents a laminated appearance with a target aspect [1]. A patient with an oral mixed mucosal and submucosal venous malformation with multiple phleboliths, which the panoramic radiograph revealed multiple round-to-oval radiopaque bodies located in the soft tissues of the left retromolar trigone. Those structures had a laminated pattern and were interpreted as phleboliths [90].

A patient presented a small mass that contained calcification in the anterior part of the masseter muscle and the plain radiograph showed a round, uniformly radiopaque lesion [91]. The same