



The Role of Ultrasonography in the Diagnosis of Periapical Lesions

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Abstract

Based on current data, ultrasound (US) has emerged as an innovative and promising imaging modality for the diagnosis of periapical lesions. Compared to conventional digital radiography and cone-beam computed tomography (CBCT), USG has the advantage of being non-invasive, free of ionizing radiation, and capable of providing additional tissue information. Ultrasound is a histopathological examination, considered the gold standard, particularly in distinguishing between cystic and granulomatous lesions.

Subject Areas

Dentistry

Keywords

Ultrasonography, Ultrasound Imaging, Periapical Pathology, Endodontic Diagnosis

1. Introduction

Ultrasonography (USG) is based on the phenomenon of sound wave propagation and reflection at the interface between different types of tissue. The frequency of the ultrasound waves used is in the range of millions of hertz (MHz) [1].

These ultrasound waves are generated by the ultrasound probe, or transducer, which contains a ceramic element with piezoelectric properties a technology invented by Wilhelm Hankel in 1881 that enables the conversion of electrical energy into mechanical energy, and vice versa [2].

The first data on ultrasound diagnosis in dentistry were reported in 1963 by

Baum *et al.* [3].

It also allows for the identification of vascularization in lesions using power Doppler and color Doppler, and is capable of distinguishing cystic lesions from solid lesions; it is also useful for distinguishing benign masses from malignant masses [3].

Ultrasound is an imaging technique used to visualize subcutaneous body structures such as tendons, muscles, joints, blood vessels, and internal organs in order to detect certain conditions or injuries [4].

To convert an electrical signal into an image, several steps are required:

- Amplification of the electrical signals,
- Digitization and computer processing using different modes (A, B, etc.).

“Mode A” (Amplitude mode) uses a single piezoelectric crystal to create a one-dimensional image that scans only a single line, which is the ultrasound probe’s beam path. This mode was the first to be used but is rarely employed today.

“Real-time B-mode” (Brightness mode) is currently the most widely used because it allows for the visualization of 2D images using an array of piezoelectric crystals (128 or more) [5].

The advantage of this mode is that it frees up space on the screen, allowing an image to be displayed that is refreshed several times per second, thereby producing a moving image on the screen. Moving the probe over the area of interest changes the anatomical view, thus providing a real-time three-dimensional representation of the space [6].

2. Methodology

Ultrasound has been studied for its ability to identify various lesions and to distinguish benign masses from malignant ones. The PICO criteria were used to formulate the research question, which was to determine the contribution of ultrasound compared to other diagnostic techniques.

The methodology used for this literature review was based on two strategies: an electronic search of databases such as PubMed, ScienceDirect, and Google Scholar, as well as a manual search using the reference lists of the selected articles.

Inclusion criteria included articles published in English and French between 1997 and 2022, clinical studies in humans, and descriptive studies. The electronic search yielded 1128 articles on PubMed, 295 articles on Google Scholar, and 474 articles on ScienceDirect. A bottom-up manual search strategy was also used to identify additional articles. Exclusion criteria included articles that did not meet the research objectives, articles published in a language other than English or French, and articles published before 2016. The selected articles underwent a systematic critical review, and only those of sufficient methodological quality were retained.

3. Results

Ultrasound is generated by a probe or transducer using piezoelectric materials

such as lead zirconate or barium titanate. These materials have the ability to contract and emit an acoustic wave when an electric current is applied. The force of the compression influences the electric current produced. In addition, phased array techniques allow for control of the direction and depth of the ultrasound focus, while stretching the piezoelectric crystals modifies the voltage generated.

The generated ultrasonic wave penetrates the body and exits through the tissues being examined in the form of mechanical oscillations from the waves reflected by the target object, or “echoes”.

The piezoelectric material acts as a receiver of acoustic waves, generating an electric current in response to the reflected wave. The characteristics of the acoustic waves, such as speed, wavelength, frequency, and intensity, vary between the initial wave and the returning wave. The wave velocity is calculated by multiplying the wavelength by the frequency. Ultrasonic waves propagate through human tissue at an average speed of 1540 m/s, similar to that in water. In soft tissues and fluids, ultrasound travels as longitudinal waves, aligned with or opposite to the direction of motion of the medium. In bone, transverse waves accompany the longitudinal waves. When an acoustic wave crosses a tissue interface, only its wavelength changes, and the source frequency remains unaffected, since the speed of the acoustic wave is characteristic of the medium through which it is transmitted [5].

The ultrasonic fields generated by a piezoelectric crystal include the near field, which is cylindrical and constant and the far field, where the beam diverges. The near field, which is inhomogeneous due to wave interference, increases with the size and frequency of the probe. Due to tissue heterogeneity, ultrasound interacts with various internal structures and tissue interfaces (fluids, calcifications, gases, discontinuities). Soft tissues have impedances similar to those of water. The interactions of ultrasound waves with these areas of varying impedance alter their properties, generating physical phenomena similar to those in optics, such as reflection, diffraction, refraction, scattering, absorption, and emission; these phenomena involve the release of thermal energy and include reflection, diffraction, refraction, scattering, and absorption (Figure 1).

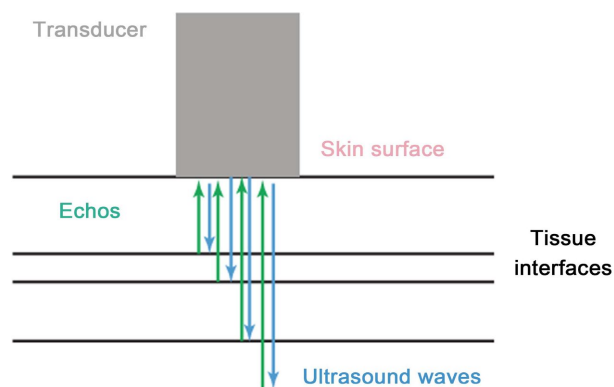


Figure 1. Diagram illustrating the basic principles of ultrasound. Echoes return to the transducer after bouncing off tissue interfaces at various depths.

When areas with very different impedances are scanned, such as the interfaces between soft tissue and bone and between soft tissue and air, strong reflections occur. The reflection of acoustic waves is greatest at a right angle and decreases as the angle of incidence becomes smaller. Scattering and absorption attenuate the ultrasound wave, limiting its penetration depth (**Figure 2**). A portion of the acoustic wave, picked up by the transducer acting as a receiver, generates an electrical signal that is displayed on the screen in real time as a two-dimensional black-and-white image (B-mode brightness mode) [7].

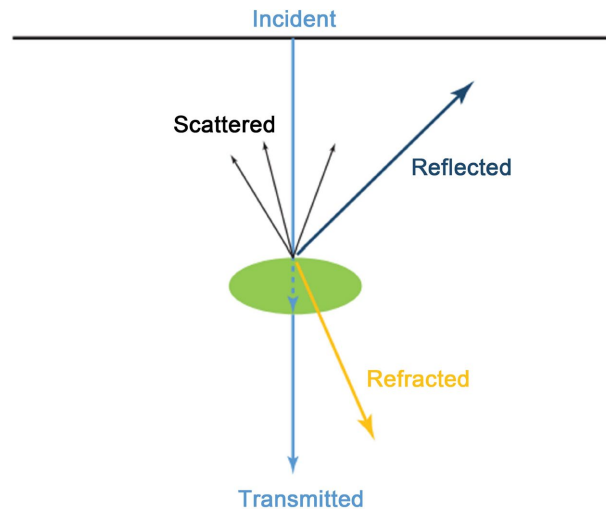


Figure 2. Physical phenomena involved in the propagation of ultrasonic waves within the object under examination.

The brightness of the pixels depends on the amplitude of the echoes, and tissue depth is calculated using the constant speed of sound and the round-trip time of the wave. The final image, similar to a sonar map, displays structures close to the probe at the top of the screen and deeper structures at the bottom of the screen [5].

The B Mode, using a relatively large probe operating at 7.5 to 10 MHz, should be the preferred choice for the differential diagnosis of soft tissue surfaces, including conditions involving the salivary glands and lymph nodes. Conversely, B-mode using a small 7.5 - 10 MHz probe should be used to determine the presence or absence of mass-like lesions of the tongue, including benign or malignant tumors of the tongue [8].

B-mode imaging is used to assess echogenicity. Hyper-echogenicity refers to an area with significant internal echoes, while anechogenicity refers to an area lacking internal echoes. While areas with identical or similar echogenicity are called isoechoic, hypoechoic lesions are defined by echogenicity lower than that of neighboring structures (**Figure 3**). When an ultrasound beam is fully reflected off the outer surface of a structure, such as a condyle or an extremely dense lesion like a calcification, a post-acoustic shadow results. When a liquid passes through a cyst or a low-density lesion, it does not obstruct the ultrasound, allowing a larger por-

tion of the beam to reach the underlying tissues. This generates more echoes behind the lesion, a phenomenon known as post-acoustic enhancement.

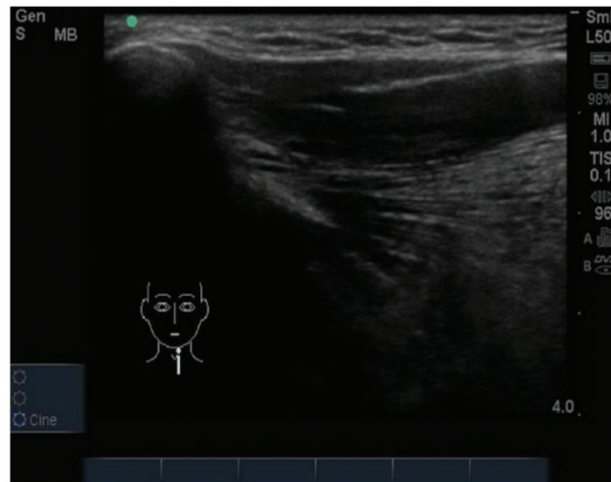


Figure 3. Example of a B-mode ultrasound image showing, among other features, the hyperechoic outer cortex of the mandibular symphysis (upper left corner of the image) with post-acoustic shadowing.

Mode A (amplitude mode) is simpler than Mode B because it displays the amplitude of the peaks as a function of time and depth, rather than showing how the echoes are distributed across a two-dimensional cross-section. The probe is positioned on the skin's surface and is not moved during the examination in this type of presentation. Consequently, only moving objects generate images in the form of high-amplitude echoes. In ophthalmology, this mode is used to calculate the distances between the different parts of the eye [5].

In M-mode, also known as Time-Motion mode, the transducer remains stationary, and a single selected ultrasound beam is transmitted and received. On the screen, the time axis displays all objects that reflect ultrasound waves. Echoes are displayed as pixels in this type of image, and their brightness varies depending on the intensity of the echo. In this mode, a very high sampling rate is useful because it allows for the detection and quantification of extremely rapid movements. Most cardiologists use M-mode. Hyperechogenicity refers to an area with significant internal echoes, while anechogenicity refers to an area lacking internal echoes (Figure 4). While areas with identical or similar echogenicity are called isoechoic, hypoechoic lesions (Figure 5). are defined by echogenicity lower than that of neighboring structures.

Harmonic tissue imaging utilizes the nonlinear propagation of ultrasound, where the variable speed of the waves (faster at high pressure, slower at low pressure) distorts their shape. This distortion generates harmonics (multiples of the fundamental frequency), but only the second harmonic, which has sufficient amplitude, is used for imaging. THI improves the signal-to-noise ratio, reduces re-

verberation artifacts, and optimizes axial and lateral resolution, thereby providing more accurate and less noisy images.



Figure 4. Example of a B-mode ultrasound image showing a hypoechoic, nearly anechoic intraglandular lymph node (marked with a compass) in the right parotid gland, with post-acoustic enhancement.

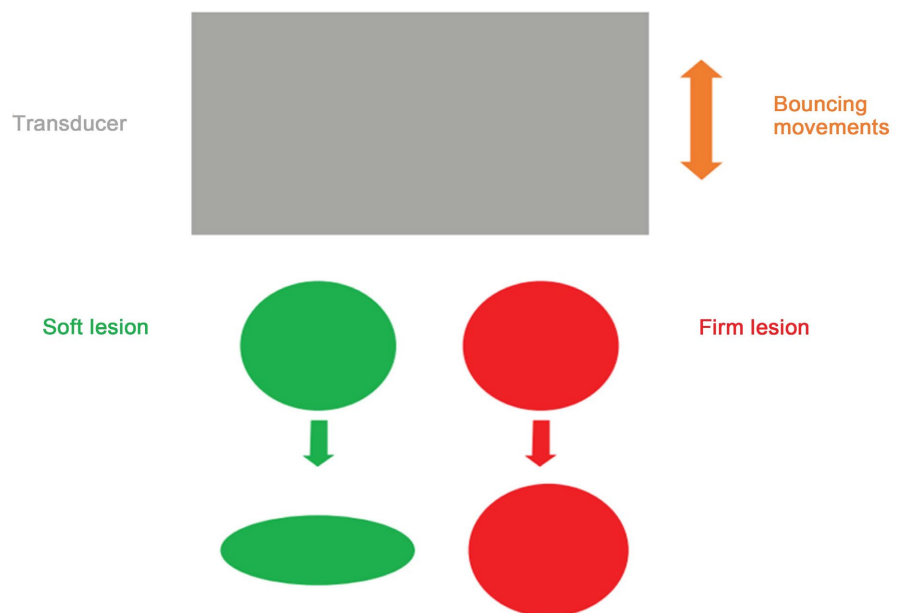


Figure 5. Diagram of deformation elastography-during compression caused by the transducer's rebound, soft lesions change shape, while firm lesions do not deform.

Using US elastography, it is possible to assess tissue stiffness by analyzing how its shape changes in response to an applied external stimulus, such as pressure or the transmission of an acoustic pulse that propagates through the tissue in the form of a shear wave.

A color-coded map (**Figure 6**) provides a qualitative illustration of areas of varying stiffness. Young's modulus values, expressed in kilopascals, offer a quantita-

tive assessment, which is available on certain American devices [9]. This technique is currently being studied in the maxillofacial field, targeting the salivary glands, lymph nodes, masticatory muscles, tumors of the palate, and tongue carcinomas. Its usefulness is already recognized for diagnosing breast lesions, thyroid nodules, and Musculo keletal applications. Using ultrasound elastography, it is possible to assess tissue stiffness by analyzing how its shape changes in response to an applied external stimulus, such as pressure (Figure 7) or the transmission of an acoustic pulse that propagates through the tissue in the form of a so-called shear wave [7] [10].

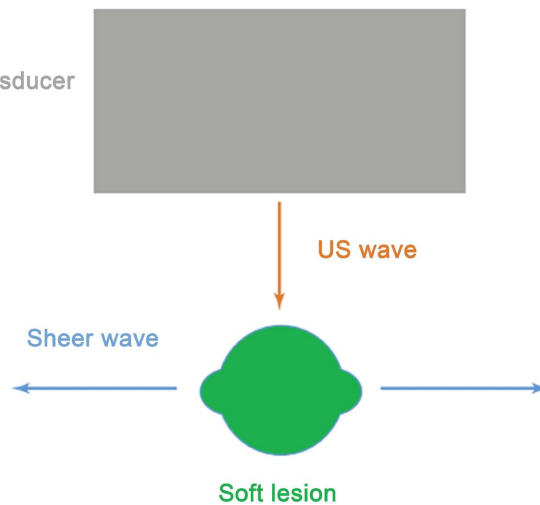


Figure 6. Schematic diagram of shear-wave elastography. The ultrasonic wave pulse distorts the soft tissue lesion, generating a shear wave that propagates transversely to the original wave.

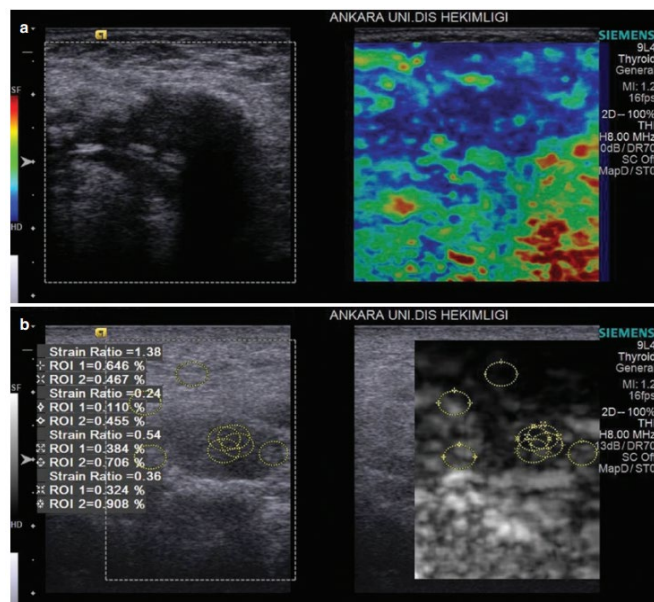


Figure 7. Example of strain elastography. (a) Color map of elasticity; (b) Estimation of strain ratios in selected regions of interest.

3.1. Advantages and Disadvantages of Ultrasonography

Ultrasonography has both advantages and disadvantages in the detection of peri-apical lesions.

3.1.1. Advantages

- 1) No ionizing radiation.
- 2) Reproducible, low-cost examination.
- 3) Portable.
- 4) Good visualization of inflammatory soft tissues.
- 5) Fast and comfortable.
- 6) Muscle structures are clearer than on CT scans.
- 7) Evaluation of the submandibular and sublingual salivary glands. Sialoliths in the parotid gland appear as hyperechoic spots with a characteristic acoustic shadow.
- 8) Ultrasound-guided needle biopsy is recommended as a safe and reliable technique for the diagnosis of cervicofacial masses.
- 9) Imaging of choice in cases where CT or conventional X-rays are contraindicated (e.g., in pregnant women and patients with cervical spine injury).
- 10) In cases of trauma, ultrasound can be used to assess potential fracture lines in the injured bone through real-time examination.
- 11) Serves as an aid in the diagnosis of temporomandibular disorders, in dental implantology, and for measuring the thickness of muscles and soft tissues.

3.1.2. Disadvantages

- 1) Ultrasound is an “operator-dependent” technique; results depend on the examiner’s skill and experience, as well as on the position of the probe, which determines the plane of the image.

This manual positioning of the probe varies from one examination to another and is not known in advance, resulting in findings that are difficult to reproduce. The operator’s ability to correctly interpret the images is also a factor to consider.

- 2) Clinically, only the bone surfaces and not the entire cortex or cancellous bone can be visualized in cases of clear lesions, due to the ultrasonic frequencies. If the lesion is very deep or if the surrounding bone is very thick, the ultrasonic waves are absorbed by the bone.

- 3) When archived, the images can be difficult to orient and interpret.

- 4) The difficulty in visualizing the TMJ using ultrasound stems from limited access to deep structures, particularly the disc, due to the absorption of sound waves by the lateral aspect of the condylar head and the zygomatic process of the temporal bone.

- 5) Ultrasound waves do not visualize bones and do not pass through air, which acts as an absolute barrier, both during transmission and reflection [5].

3.1.3. Indications and Contraindications of Ultrasonography

Ultrasonography is used for diagnostic imaging of the salivary glands, the thyroid

gland, the lymph nodes, the muscles (masticatory, neck, and facial), the tongue, the oral cavity and oropharynx, the palate, periodontal tissues, the temporomandibular joint (within a limited range), extracranial nerves, paranasal sinuses, major blood vessels, and the larynx in the head and neck region [7] [11] [12].

Using ultrasound, the following conditions can be evaluated: inflammation, cysts, primary and metastatic cancers, congenital malformations, masseter muscle lesions, vascular lesions, peritonsillar abscesses, lichen planus, bullous diseases, certain fractures (zygomatic arch, nasal bone), obstructive sleep apnea, oropharyngeal dysphagia (M-mode), as well as the identification of foreign bodies. Ultrasound is also used to guide fine-needle aspiration biopsy, abscess drainage, TMJ arthrocentesis, TMJ injections of sodium hyaluronate steroids, as well as intramasseteric injections of botulinum toxin for bruxism and/or in cases of masseter hypertrophy [13] [14]. Treatment monitoring can also be performed using ultrasound.

There are no contraindications to ultrasound other than the patient's lack of cooperation. It can be performed on pregnant women, newborns, and infants because the average intensity of the emitted acoustic wave is generally less than 20 mW/cm², a value considered safe [1].

3.1.4. Limitation of Doppler Imaging

The Doppler effect is the change in the frequency of a wave perceived by an observer when there is relative motion between the wave source and the observer.

Doppler imaging has certain limitations: it is more difficult to visualize small veins than large ones, and a less sensitive device may fail to detect low blood flow, leading to a false diagnosis of occlusion. Furthermore, visualizing deep vessels is more complicated than visualizing superficial vessels, except in the head and neck region [15].

3.1.5. Ultrasound Imaging in Endodontics

Dental infections can have mechanical, chemical, or bacterial causes. Mechanical causes include trauma, fractures, bruxism, and temperature changes. Chemical causes include various acidic compounds [16]. Although lesions are frequently found in the periapical region, the majority of these lesions are inflammatory in nature [17]. The dental pulp consists of vascularized connective tissue, and when it is damaged by physical, chemical, or bacterial factors, an inflammatory process begins, ultimately leading to apical lesions. For the diagnosis, management, and follow-up of inflammatory lesions, periapical radiographs and clinical evaluation are often sufficient without the need for CBCT imaging [18] [19].

However, the inflammatory process encompasses all of the host's dynamic responses to infection, in addition to periapical bone loss. Standard X-rays are unable to reveal this information accurately in the early stages of the lesion [20] [21].

In order to monitor the lesion's content, tissue architecture, vascularization, and mineralization during the diagnostic, treatment, and follow-up phases, it is necessary to use an additional imaging modality.

3.2. Classification of Periapical Lesions

Periapical lesions are classified into five main groups:

- 1) Symptomatic (acute) apical periodontitis,
- 2) Asymptomatic (chronic) apical periodontitis,
- 3) Condensation osteitis,
- 4) Acute apical abscess,
- 5) Chronic apical abscess.

3.2.1. Description of Each Lesion Type

Periapical lesions are inflammatory or infectious pathologies affecting the tissues surrounding the dental apex. They generally occur following pulp damage, most often related to bacterial infection, pulp necrosis, or trauma. The development of these lesions results primarily from the body's immune response to microbial aggression originating from the root canal system.

3.2.2. Acute (Symptomatic) Apical Periodontitis

Acute apical periodontitis (AAP) refers to acute inflammation of the periapical tissues. When it is primary, it is a short-lived inflammation that originates in healthy periapical tissue. The etiology is primarily microbial, although other factors may be involved (over-occlusion from restorations, over-extension of endodontic instruments, over-extension during root canal filling, etc.). 1) Clinically: it is accompanied by moderate to severe spontaneous pain, exacerbated by biting or percussion. 2) Radiographically: It is characterized by little or no apical radiolucency, with or without slight thickening of the desmodontal ligament. 3) Histologically: we observe the presence of several immune cells within a well-defined area (macrophages, leukocytes, etc.). There may also be early bone and root resorption that is not visible on radiographs [22].

Symptomatic apical periodontitis is referred to as secondary when it develops on top of pre-existing chronic periodontitis. This acute phase may be followed by: 1) Spontaneous healing, when the cause is mechanical. 2) Progression to a chronic state. 3) The formation of a primary abscess when highly pathogenic bacteria are involved.

3.2.3. Asymptomatic (or Chronic) Apical Periodontitis

This condition involves chronic inflammation associated with slow destruction of the periapical tissues. The primary cause of this type of lesion is low-grade pulp necrosis, though it can sometimes result from apical periodontitis.

- Clinically: It is mostly asymptomatic, with percussion that is painless or only slightly tender.
- Radiographically: It ranges from a simple interruption of the lamina dura to extensive bone destruction.

3.2.4. Condensing Osteitis

This is a chronic bone inflammation localized at the periapical region, resulting in hypermineralization. It is most often secondary to chronic pulpitis.

- Clinically: symptoms will vary depending on the cause (chronic pulpitis or necrosis). It is often asymptomatic but may also be associated with pain. The discovery of this lesion is often incidental.
- Radiographically: It is characterized by a concentric radiopacity around the apex. This sign is pathognomonic of the lesion.
- Histologically: It is primarily characterized by the replacement of cancellous bone with denser trabecular bone. In some cases, the cancellous bone may also be replaced by areas of fibrosis or by an inflammatory infiltrate.

3.2.5. Acute Apical Abscess

An abscess is a localized collection of pus in the periapical region resulting from pulp necrosis.

- Clinically: The acute phase is characterized by spontaneous pain, exacerbated by percussion and palpation, and may or may not be associated with swelling (depending on whether the abscess is confined within the bone or not).
- Radiographically: Signs vary: no abnormalities, thickening of the periodontal ligament, or a distinct radiolucency.
- Histologically: Granulomatous tissue is found, within which a zone of liquefaction has developed containing various cell types: leukocytes, polymorphonuclear neutrophils, cellular debris, and purulent exudate.

3.2.6. Chronic Apical Abscess

A chronic apical abscess results from an old lesion that eventually drains into the oral mucosa or, in some cases, even through the skin via a fistula.

Clinically: this lesion is usually asymptomatic, but there are some cases in which it can become painful if the fistula's tract is plugged.

Radiographically and histologically: the characteristics are similar to those of AAP.

4. Discussions

The primary goal of endodontics is to identify and treat periapical lesions (PALs) in order to preserve natural teeth and halt their direct and indirect systemic effects. Imaging modalities are crucial for identifying this condition, especially since APL is often asymptomatic. The most relevant classical and contemporary literature describes the currently most accurate and advanced diagnostic imaging technologies for the early and reliable detection of APL. Dental panoramic tomography (DPT) is a traditional examination that is still considered useful for determining the diagnosis of APL in specific regions of the maxillary bones. Periapical radiographs (PAs) constitute a reliable and standard examination, with limited and well-known restrictions [23].

However, the only technology that guarantees the early and reliable detection of all periapical lesions in the jaws with a low risk of false positives is cone-beam computed tomography (CBCT). These methods can be successfully applied using non-ionizing radiation tests such as magnetic resonance imaging (MRI) or ultra-

sound. Differential diagnoses can be established using the information that MRI and ultrasound (USG) reveal about the precise characteristics of lesions, such as the presence and extent of vascular supply, their content, and their relationships with surrounding soft tissues. In addition, volumetric measurement of the PAL is possible with all three-dimensional systems (CBCT, USG, and MRI). Innovative research on artificial intelligence is making slow progress in the detection of periapical radiolucencies on panoramic radiographs, periapical radiographs, and CBCT, though with promising results. Finally, it is established that all imaging techniques must be combined with a thorough clinical examination and a high level of operator skill [23].

4.1. Ultrasonography versus Radiography in the Differentiation of Periapical Lesions

4.1.1. How Ultrasound Works

The use of ultrasound imaging (USG) to diagnose periapical lesions is a simple and reproducible technique that can complement conventional and digital radiography. USG for periapical lesions works by electrically stimulating a piezoelectric crystal called a transducer, which produces ultrasound waves. Some of these ultrasound waves are reflected back toward the transducer when the beam encounters an interface between tissues with different acoustic impedances. The electrical pulses from the echoes can then be displayed on an oscilloscope to produce an image of the tissues, in order to identify periapical lesions and distinguish periapical cysts from granulomas [22].

4.1.2. Benefits of Ultrasonography in Endodontics

- This examination provides a comprehensive view of the dental arches and jaws in a single image.
- It allows for the identification of anatomical structures such as the sinuses, nasal cavities, the inferior alveolar canal, and its exit through the mental foramen.
- The presence of intraosseous pathologies can be detected or confirmed.
- Radiation exposure is low; the effective dose of a 2D panoramic X-ray ranges from 4.0 to 30 μSv [21].
- Real-time dynamic imaging facilitates diagnosis and treatment.
- Image resolution in the millimeter range provides “high precision”.

This enables the diagnosis of sinus tracts, complicated cystic lesions, infected cysts, and mixed cyst-granuloma lesions.

4.1.3. Limits of Ultrasonography in Endodontics

A thin buccal cortical plate is necessary for USG waves to pass through and identify periapical lesions, which constitutes one of the limitations of USG imaging. Moreover, lesion size is often underestimated. Variations in lesion size observed with USG may be explained by small hypoechoic or anechoic lesions, which are represented by the acoustic shadow formed by the edges of the bony cavity [22] [24].

4.1.4. Ultrasound Examination Procedure

Ultrasound has been successfully used in endodontics to visualize periapical lesions in 3D without the use of radiographic film, as well as to distinguish between cysts and granulomas. It can also provide specific information on the dimensions of the lesion and its contents (fluid, mixed, or solid) and assess their internal and external blood supply (using color Doppler or power Doppler) [25]. The ultrasound transducers best suited for dentistry are linear probes, which can be used intraorally on the gingival mucosa or extraorally on the skin; the frequencies used range from 2 to 20 MHz. The patient is in a reclining position, seated, or lying on an examination table. The probe is coated with ultrasound gel (Ultrage; Medicon) and gently moved around the area to obtain a sufficient number of transverse (axial) and longitudinal (sagittal) scans [11] [25] [26].

Differential diagnosis of periapical lesions. An ultrasound examination was performed, yielding the following images.

4.1.5. Conventional and Digital Apical Radiography

In a systematic review, Patil *et al.* (2021) compared the diagnostic accuracy of ultrasonography and traditional radiographic methods for periapical lesions. The five studies included in this comparison revealed that the use of ultrasound imaging provides the practitioner with sufficient detail to accurately distinguish periapical lesions such as cysts or granulomas [25].

4.1.6. Ultrasonography versus Histopathological Examination for the Differentiation of Periapical Lesions

Periapical lesions resulting from dental pulp necrosis are among the most common pathological conditions affecting the alveolar bone (Figure 8). Although there are numerous reports regarding benign or malignant endodontic lesions in the periapical region, the vast majority of these are periapical granulomas, cysts, or abscesses. The frequency of clinical screening to determine whether a biopsy is warranted and the extent to which this influences diagnostic accuracy are unknown. Several studies [1] have suggested that between 0.7% and 5.0% of periapical biopsies yield useful histopathological findings. However, these studies are almost certainly biased by the clinical selection process described above. Other histological studies of periapical lesions that describe only inflammatory periapical lesions of endodontic origin represent an inconsistency that has not yet been resolved [7].

In the study conducted by Gupta *et al.* (2021) [22], the diagnosis made using ultrasound was compared to the diagnosis made using histopathological examination; 25 of the 30 cases in which an ultrasound diagnosis was made were confirmed by histology. Histopathology identified 11 lesions as periapical cysts and 19 lesions as periapical granulomas. Nine of the 11 diagnoses of periapical cysts were confirmed by histopathology, and in each of these 9 cases, histology revealed the presence of a cavity lined with stratified squamous epithelium, the lumen of which contained necrotic debris and numerous impressions of cholesterol crystals. Using ultrasonography, periapical granulomas were identified in 18 cases,

and 16 of these cases were confirmed by histology, revealing the appearance of typical granulomatous tissue, where lymphocytes, monocytes, and polymorphonuclear cells were widely distributed within the connective tissue.



Figure 8. Positioning of the ultrasound probe in the anterior maxillary region; (a) Transverse extraoral ultrasound; (b) Extraoral ultrasound

Two cases presented with periapical granulomas, which were detected by ultrasound but were subsequently identified by histopathology as periapical abscesses. On ultrasonography, two cases were identified as periapical cysts and a single case as a periapical abscess; however, histology identified all three cases as periapical granulomas [22].

5. Conclusion

Based on current data, ultrasound appears to be a promising tool that outperforms conventional digital radiography and CBCT while remaining non-invasive for the diagnosis of periapical lesions, particularly in distinguishing between cysts and granulomas. It yields results very similar to those of histopathological examination. Ultrasound can be considered a superior imaging modality with increased efficacy in the diagnosis of periapical lesions compared to conventional radiography and CBCT, a finding confirmed by histopathological examinations.

Conflicts of Interest

The authors declare no conflicts of interest.

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