Ultrasound in Dentistry

Toward a Future of Radiation-Free Imaging

Husniye Demirturk Kocasarac, DDS, PhD[a,*], Christos Angelopoulos, DDS, MS[b]

KEYWORDS

• Ultrasonography • Diagnostic ultrasound • Dentistry • Jaw • Diagnosis
• Diagnostic imaging • Pathologic conditions

KEY POINTS

- Ultrasonography (US) is a non-invasive, non-ionizing, inexpensive and painless imaging tool, therefore, it can be performed as much as needed in a very short time.
- Well-known features of US are fast, cost-effective, reproducible, real time and simultaneous imaging of both hard and soft tissue, and easy tolerability by patient.
- US has been used to discover its capability to identify caries lesions, tooth fractures, soft tissue lesions, periodontal bony defects, maxillofacial fractures, and temporomandibular disorders.

REVIEW OF THE LITERATURE

Ultrasound refers to oscillating sounds with frequencies of 2 to 20 MHz, which is beyond the upper limit that humans can hear. Ultrasonography (US), also known as real-time echography or sonography, is an imaging technique based on the propagation and reflection of ultrasound waves in the tissues. The transducer includes an electrically stimulating piezoelectric crystal that converts electrical impulses to high-frequency sound waves, which are transmitted into the tissues being examined. As this sound passes through tissues with different acoustic impedances (ie, blood and muscle), part of it is absorbed within the medium; another part of it continues to penetrate and travel through the tissues. Finally, a portion of the sound is reflected back to the transducer and smaller portions of it may be scattered and lost. Echo is the part of the sound wave that is reflected back toward the surface of the body. The reflected echoes are collected by the transducer and reconverted into electrical impulses, amplified, processed, and displayed as grayscale images on a computer screen.[1]

Generally, ultrasound with frequencies between 3 MHz and 12 MHz is used in dentistry.[2] The most commonly used dental display modes are amplitude mode

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[a] Division of Oral and Maxillofacial Radiology, Department of Comprehensive Dentistry, UT Health San Antonio, 7703 Floyd Curl Drive, San Antonio, TX 78229, USA; [b] Aristotle University of Thessaloniki, Greece and Columbia University, College of Dental Medicine, Greece
* Corresponding author.
E-mail address: demirturk@uthscsa.edu

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(A-mode) and brightness mode (B-mode).[3] A-mode ultrasound is the most basic display mode after plotting the radiofrequency (RF) signal and was used often in early US. It uses a single crystal to generate a 1-dimensional image with the echo amplitude, displayed vertically, and the echo time, displayed horizontally. Currently, a standard screen image created by US machines is in B-mode. B-mode ultrasound images can be produced by moving an ultrasound probe (transducer) on a trajectory, receiving RF-echo signals from each probe position, and then transforming electrical energy into a light spot using grayscale on a monitor.[3,4]

US is a tomographic imaging technique. Sonograms (US images) are sections of certain thicknesses generated along the face of the transducer (contacts are with the tissue under examination) in the region of interest (Fig. 1). The depth of the section depends on the frequency of the transducer used. The sonogram is a composite of different shades of gray, the brightness of which depends on the frequency of the reflected echoes, which in turn depend on the ability of a tissue or structure to reflect or absorb sounds; this is known as echogenicity. With diagnostic US, tissues are classified based on their echogenicity in broad categories:

- Hyperechoic or echogenic, highly reflective tissues (very bright), such as osseous structures or cartilage
- Moderately echogenic (fairly bright), such as glands
- Hypoechoic (fairly dark), such as blood vessels and muscles
- Anechoic (very dark), such as fluids and air.

The collected echoes are processed very quickly by the US machine and images are almost instantly generated; this gives the impression of real-time imaging.

Diagnostic US has been used extensively for the assessment of soft tissue pathologic conditions of the head and neck with high-frequency transducers, including salivary gland disease (Fig. 2), neck vascular pathologic conditions, and nodal disease, as well as disease of floor of the mouth (Fig. 3). Guided fine-needle aspiration, measurement of tongue cancer thickness, and detection of metastasis to cervical lymph nodes are a few of the applications of US in soft tissue lesions.[3] In a recent study of 45 subjects, the diagnostic accuracy of US was 92.3% in cystic lesions, 87.5% in benign tumors, 81.8% in malignant tumors, 90% in space infections and abscesses, and 100% in lymphadenopathies (Fig. 4).[1]

Fig. 1. The orientation of the transducer as it is applied on the body surface to be examined determines the section generated. In this case, a transverse section is produced along the red line.