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Ultrasound: Radiation free imaging in dentistry

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Abstract
Ultrasonography is used to view internal body structures and organs. Ultrasonic images, also known as sonograms that are produced by sending pulses of ultrasound into tissue through the use of a probe, which carries a transducer containing material that produces a piezoelectric effect. The lower the frequency, the higher the penetration of tissues but the lower the potential image resolution. Intraoral USG makes it possible to visualize oral cavity organs, such as the sublingual gland and the submandibular duct, tongue, lips, tonsils, and soft palate, which are virtually impossible to image via conventional USG.

Keywords: Ultrasound, Sound waves, Hyperthermia, Acoustic cavitation.

Introduction
Ultrasonography (US) initially was a therapeutic aid, however presently it has become one of the most common imaging modality next to traditional radiology. The use of ultrasonography (US) in dentomaxillofacial region became popular in recent years as a result of increasing radiation dose concerns and economic limitations. Ultrasonography is a diagnostic method that the ultrasonic image is made by ultrahigh-frequency sound waves, which have an acoustic frequency above the threshold of human hearing.

It helps to ascertain fine detail of the surface structure of the oral and maxillofacial tissues without ionizing radiation. In diagnostic ultrasound, high frequency sound waves are transmitted into the body by a transducer and echoes from tissue interface are detected and displayed on a screen. Sound waves are emitted via piezoelectric crystals from the ultrasound transducer. Depending on the shape and configuration of the probe or transducer, view is produced. As the sound echoes off the tissue, different tissues reflect varying degrees of sound. These echoes are recorded and displayed as images to the operator. Ultrasonography (US) is a noninvasive, nonionizing, inexpensive, and painless imaging tool proven to be a valuable diagnostic tool in soft tissue assessment that also shows promise for hard tissue evaluation in dentistry. US has been investigated for its capability to identify carious lesions, tooth fractures or cracks, periodontal bony defects. US technique can be used in dentomaxillofacial region for the examination of bone and superficial soft tissue, detection of major salivary gland lesions, temporomandibular joint imaging, assessment of fractures and vascular lesions, lymph node examination, measurement of the thickness of muscles and visualization of vessels of the neck. It has the potential to be utilized in the analysis of periapical lesions and follow of periapical bone healing. It may be used for the evaluation of periodontal pocket depth and the determination of gingival thickness before dental implantology.

Mechanism of action
There are two principles which are responsible for the destruction of the tissue:

1. Hyperthermia.
2. Acoustic cavitation.

As human tissues have viscoelastic characteristics, the acoustic energy which is lost is converted into heat. Therefore, tissue temperature increases rapidly in a focal region. As temperature rises above 43°C, it leads to protein denaturation and the formation of a necrotic lesion with sharp demarcation. Increasing the focal temperature causes coagulative tissue necrosis without affecting the interceding and surrounding tissue.[1]

Advantages

1. Absence of ionizing radiation
2. Repeated examinations and low cost
3. Easy Portability
4. Well recognized in inflammatory soft tissue[2,3]
5. Fast, comfortable
6. Muscle structures clearer than computed tomography
7. Evaluation of submandibular and sublingual salivary glands. Sialolithiasis of parotid gland appears as echo-dens spots with a characteristic acoustic shadow.[2,4]
8. US guided core needle biopsy is recommended as a safe and reliable technique in the diagnosis of cervico-facial masses.[5,6]
9. Imaging of choice when there is a contraindication to CT or plain films (for example, in pregnant women and patients with cervical spine injuries.[7,8]
10. When a trauma occurs, US can be used to investigate potential fracture lines of the injured bone through a real time examination.[9]
11. Diagnostic aid in temporomandibular disorders, implant dentistry, and to measure muscle and soft tissue thickness.[10]

Disadvantages

1. The technique is very operator dependent.[12]
2. Clinically only the bone surfaces and not the whole cortex or spongiosa can be visualized in intact done due to ultrasound frequencies.[13] If lesion is very deep or surrounding bone is very thick, ultrasound waves are absorbed by bone.
3. Images when archived they may be difficult to orientate and to interpret.[14]
4. The difficulty of picturing the TMJ using ultrasounds depends on the limited accessibility of the deep structures, especially the disc, due to absorption of the sound waves by the lateral portion of the head of the condyle and the zygomatic process of the temporal bone.[15]
5. Ultrasonography waves do not visualize bone or pass through air, which acts as an absolute barrier during both emission and reflection.[15]

Ultrasound appearances in pathology[11]

S. No	Pathology	Ultrasound apperance
1	Edema	Isoechoic with internal thickening of subcutaneous layer
2	Preabscess	stage Mixed hypoechoic and hyperechoic septa
3	Abscess	Anechoic with no internal echogenicity
4	Cellulitis	Diffuse reticulated (cobblestone)hyperechoic appearance with hypoechoic septa
5	Granuloma	poorly defined hypoechoic area
6	Cystic lesion	Hypoechoic well-contoured cavity
7	Odontogenic tumor	Hyperechogenic
8	Lipoma	Hyperechoic relative to the adjacent muscle with heterogenous internal echoes.
9	Sialolithiasis	Intra-glandular ductal dilatation and an intra-ductalechogenic filling defect casting posterior acousticshadowing
10	Sialadenitis	Hypoechoic
11	Mumps	Hypoechoic
12	Sjogren's syndrome.	Early stage - normal echogenicity. Late features - heterogeneous echopattern with multiple round hypoechoic areas within theparenchyma.(sometimes containing frank cystic changes) long-standing disease - appear as small and atrophic with a

		hypoechoicechotexture or may have a reticulated pattern
13	Pleomorphicadenoma	Homogeneous, hypoechoic
14	Warthin'stumour	Hypoechoic lesion with internal heterogeneity
15	Metastatic lymphnode	Hypoechoic, round and without an echogenic hilus
16	Tuberculosis	Round, with an S/L ratio greater than 0.5, and appearhypoechoic, without an echogenic hilus
17	Hemangioma	Hypoechoic, heterogenousechopattern
18	Oral submucousfibrosis	Hyperechoic fibrous bands

Source of Funding

None.

Conflict of Interest

None.

References

1. Dogra VS, Zhang M, Bhatt S. High-intensity focused ultrasound (HIFU) therapy applications. *Ultrasound Clin* 2009;4:307-21.
2. Kumar SB, Mahabob MN. Ultrasound in dentistry - a review. *J Indian Academy Dent Spec* 2010;1:44-5. [Google Scholar]
3. Lauria L, Curi MM, Chammas MC, Pinto DS, Torloni H. Ultrasonography evaluation of bone lesions of the jaw. *Oral Surg Oral Med Oral Pathol Oral Radiol Endod* 1996;82:351-7. [PubMed] [Google Scholar]
4. White SC, Pharoah MJ. Oral Radiology Principles and Interpretation. *Salivary Gland Radiol* 2008;2:665-6. [Google Scholar]
5. Newman PG, Rozycki The history of ultrasound. *Surg Clin North Am* 1998;78:179-95. [PubMed] [Google Scholar]
6. Sharma S, Rasila D, Singh M, Mohan M. Ultrasound as a diagnostic boon in Dentistry a review. *Inter J Sci Study*. 2014;2:70-6. [Google Scholar]
7. Nezafati S, Javadrashid R, Rad S, Akrami S. Comparison of ultrasonography with submentovertex films and computed tomography scan in the diagnosis of zygomatic arch fractures. *Dentomaxillofac Radiol* 2010;39:11-6. [PMC free article] [PubMed] [Google Scholar]
8. Friedrich RE, Plambeck K, Bartel-Friedrich S, Giese M, Schmelzle R. Limitations of B-scan ultrasound for diagnosing fractures of the mandibular condyle and ramus. *Clin Oral Investig* 2001;5:11-16. [PubMed] [Google Scholar]
9. Chen YL, Chang HH, Chiang YC, Lin CP. Application and development of ultrasonics in dentistry. *J Formos Med Assoc* 2013;112:659-65. [PubMed] [Google Scholar]
10. Demirturk Kocasarac H, Angelopoulos C. Ultrasound in Dentistry: Toward a Future of Radiation-Free Imaging. *Dent Clin North Am* 2018;62(3):481-9.
11. Reddy L. Diagnostic and Therapeutic Ultrasound in Dentistry. *J Dent& Oro-facial Res* 2015;11(1).
12. Elliot T L, Downey D B, Tong S, McLean C A and Fenster A. Accuracy of prostate volume measurements in vitrousing three-dimensional ultrasound. Acad. *Radiol* 1996;3(5):401-6.
13. R.E. Friedrich, K. Plambeck, S. Bartel-Friedrich. Limitations of B-scan ultrasound for diagnosing fractures of the mandibular condyle and ramus. *Clin Oral Invest* 2001;5:11-6.
14. Rachel S. Oeppen, Gibson D and Peter A. Brennan. An update on the use of ultrasound imaging in oral and maxillofacial surgery. *Br J of Oral Maxillofac Surg* 2010;48(6):412-8.
15. Marcello Melis, SimonaSecci and Caroline Ceneviz. Use of ultrasonography for the diagnosis of temporomandibular joint disorders: A review. Am J Dent.

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