

# Application Of Ultrasounds In Dentistry: A Review

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## Abstract

The utilisation of advanced diagnostic imaging modalities in oral and maxillofacial radiology includes modern computed tomography, cone-beam computed tomography, magnetic resonance imaging, nuclear medicine, ultrasonography (USG), xeroradiography, and arthrography, to name just a few. Since its beginnings, USG has been used in the field of medicine to identify lesions for both diagnostic and therapeutic purposes. USG is a technique that captures photographs in real-time without the use of ionising radiation. Soft-tissue lesions are simpler to diagnose with USG than hard-tissue lesions are.

**Keywords:** Ultrasounds, USG, Dentistry, Imaging, Diagnosis, Ultrasound Therapy

## INTRODUCTION:

The foundation of a precise diagnosis and a well-thought-out treatment strategy is imaging. The current modalities are successfully redefining the guidelines for diagnostic imaging thanks to recent developments in the field. Numerous imaging modalities have a significant role in the diagnosis, identification, and discovery of lesions in the oral and maxillofacial region. The field of imaging has undergone a revolution with the introduction of techniques like magnetic resonance imaging (MRI), computed tomography (CT), and ultrasonography (USG), which has reduced treatment uncertainty.<sup>1</sup> Due to advantages such the use of safe nonionizing radiation, widespread accessibility, simplicity, low cost, and the absence of artefacts brought on by metallic restorations, USG performs better than other imaging modalities. A USG feature called real-time imaging makes it possible to analyse echoes quickly enough to detect movements.<sup>2,3</sup>

The oral and maxillofacial region's soft tissue and bone can be seen in both normal and diseased circumstances using ultrasound (US), one of the most sophisticated imaging modalities.<sup>4</sup> It is generally known that ultrasonography can be used to diagnose a variety of soft tissue abnormalities. It is important to note, however, that its development in therapeutic applications, whether used alone or in conjunction with other imaging modalities, has made it an important instrument in the fields of dental and medical sciences.<sup>5</sup>

Ultrasound has a long history of being used for diagnostic purposes. Dentures, myofacial pain dysfunction syndrome, temporomandibular joint disorder, cystolithotripsy of salivary calculi, craniofacial deformities, descaling of teeth, root canals, amalgam fillings, extraction of teeth, cleaning of instruments prior to sterilisation, and dentures are all treated by the therapeutic US in dentistry.<sup>6</sup> Purpose of present review of literature is to discuss diagnostic and therapeutic application of ultrasound in dentistry.

## History of Ultrasound:

The history of using sound waves to measure distance beneath water should likely be the starting point for the development of ultrasound applications in medicine. SONAR stands for Sound Navigation and Ranging. Italian scientist and physician Lorenzo Spallazani made the first attempt to prove the presence of inaudible sound in 1794.<sup>7</sup>

Jacques and Pierre Curie discovered high-frequency sound waves in the late 1800s when they exposed specific crystals to an alternating current at their resonant frequency. Paul Langevin was the first to document the biological effects of ultrasound in 1926 after watching fish respond violently and fatally to powerful ultrasonic fields.<sup>8</sup>

Instead than focusing on ultrasound's therapeutic uses at first, the bulk of researchers initially tended to focus on its diagnostic use. But the therapeutic application of USG was discovered in the late 1940s. In addition to a number of other infectious diseases, USG was utilised to treat chronic osteomyelitis and osteoradionecrosis.

Ian Donald of Obstetrics and Gynecology first used ultrasound in diagnostic medicine in 1956.<sup>9</sup> In 1963, Baum et al. developed the first application of diagnostic ultrasonography in dentistry, using 15 MHz wave imaging to scan the interior anatomy of teeth. Since then, a great deal of research has been done on the clinical applications of USG in dentistry, with Palou et al. (1987) providing the most significant contribution in the measurement of periodontal bone morphology. The diagnosis of soft tissue lesions and bone disease in the oral and maxillofacial region is performed with USG, a noninvasive, nonionizing, safe, widely accessible, and affordable advanced imaging tool.<sup>8</sup>

### **Ultrasound as Diagnostic Tool in Dentistry:**

In the medical profession, ultrasound has been successfully used to diagnose pathologies of the belly, breast, liver, spleen, kidneys, and other superficial soft tissue disorders. Studies have demonstrated that using ultrasound to diagnose soft tissue abnormalities such as salivary gland diseases, cysts, and tumours that affect the maxillofacial region is a successful method. Infections of the maxillofacial region's superficial face space have also been evaluated using it.

### **Imaging of Structures in Head and Neck<sup>10,11</sup>**

#### **Swellings in the head and neck:**

USG can be used to differentiate between cervical lymphadenopathy and cystic or solid neck masses. It helps to distinguish between benign and cancerous tumours as well as intra- and extraglandular abnormalities of the salivary glands.

- **Inflammatory Swellings:** Edema, infiltrate, pre-abscess, echo-poor abscess, and echo-free abscess were the initial classifications made by Sigert et al. of the USG appearances of inflammatory swellings.
- **Cystic Swellings:** Because cysts are filled with fluid or air, they look as anechoic patches. There is little to no attenuation of sound in homogeneous liquids, and there are no structures to produce internal echoes, therefore the distal part of the cystic mass experiences improved sound transmission. If the cyst becomes infected, the lesion's contents may echo, creating a hypoechoic region. For instance, sebaceous cysts and branchial cysts typically present as well-defined, homogenous, anechoic or hypoechoic zones with posterior acoustic amplification.
- **Benign Neoplasm:** Pleomorphic adenoma is a benign tumour that is rounded, confined, hypoechoic, and acoustically enhanced distally. Lipomas are typically recognised as oval or elliptical masses with uniform edges and an internal echotexture that is typically striped or feathery.
- **Malignant Neoplasms:** The USG characteristics vary depending on the tumour grade. Larger lesions manifest with evident malignant traits such as uneven, poorly defined borders and heterogeneous internal structure, while low-grade malignant neoplasms resemble pleomorphic adenoma.

#### **Oral Submucous Fibrosis:**

In cases with oral submucous fibrosis, ultrasonography can be used to show the number, length, and thickness of the fibrotic bands as well as the distribution of the area's overall vascularity. Additionally, USG aids in the identification of weak fibrotic bands in clinically healthy buccal mucosa. Compared to the mucosa between the bands, where vascularity was found to be normal, the mucosa atop the band exhibits a lower flow velocity.<sup>3</sup>

#### **Temporomandibular Joint:**

TMDs have been assessed using High Resolution Ultrasonography (HRUS), which displays "real-time" images of the articular disc during the opening of the mouth. The mandibular condyle and the articular eminence are seen as hyperechoic lines in the mandibular condyle's and the disc's USG image, respectively.<sup>12,13</sup>

#### **Mid-facial Fracture:**

In cases of trauma, USG has shown to be effective in locating a midfacial fracture. Sinha P and David MP investigated the zygomatico-orbital complex, which includes the infraorbital boundary, orbital floor, frontozygomatic suture, lateral or medial wall of orbit, and body of zygoma. They discovered that USG could image zygomatico-orbital fractures with accuracy and dependability. The imaging of the zygomatic arch and frontal sinus wall in midfacial fractures was found to benefit most from ultrasound.<sup>8</sup>

<b>Table no. 1: Diagnostic application of Ultrasound<sup>3</sup></b>	
Swellings in the orofacial region	
Salivary gland disorders	
Periapical lesions	
Lymph nodes - benign/malignant	
Intraosseous lesions	
Temporomandibular disorders	
Assessment of masticatory muscles in temporomandibular dysfunction	
Congenital vascular lesions of the head and neck	
Primary lesions of the tongue	
Fractures of mandibular condyle and ramus and midfacial fracture	
Detecting the foreign bodies	
Miscellaneous lumps and bumps of the head and neck	
Ultrasound guided core needle biopsy	
Submandibular gland injection of botulinum toxin for hypersalivation in cerebral palsy	
Basket retrieval of salivary stones	

<b>Table no. 2 Ultrasound appearance in Pathology<sup>14,15</sup></b>	
Edema	Isoechoic with internal thickening of subcutaneous layer
Abscess	Anechoic with no internal echogenicity
Cellulitis	Diffuse reticulated (cobblestone) hyperechoic appearance with hypoechoic septa
Cystic lesion	Hypoechoic well-contoured cavity
Odontogenic tumor	Hyperechogenic
Sialadenitis	Hypoechoic
Mumps	Hypoechoic
Hemangioma	Hypoechoic, heterogenous echo pattern
Oral submucous fibrosis	Hyperechoic fibrous bands

## THERAPEUTIC USE OF ULTRASOUND IN DENTISTRY

### Ultrasound Therapy for Temporomandibular Disorders:

One of the most frequent causes of discomfort in the mouth and face, second only to odontogenic pain, is temporomandibular dysfunction (TMD), which affects millions of people.<sup>16</sup> Recently, US has become increasingly popular as a physical treatment for a number of TMJ disorders.

Ultrasound is made up of sound waves that have frequencies greater than what humans can hear. The destruction of articular cartilage and excessive apoptosis of chondrocytes in the soft tissue of bone and joint as a result of increased NO content and the imbalance of local metabolism in the joint were both shown to occur during the occurrence and development of TMD, according to earlier studies. It has been demonstrated that US can lower chondrocyte apoptosis and excessive cytokine content in the articular fluid. It limits the release of inflammatory cytokines and encourages the growth of articular cartilage to repair cartilage damage.<sup>17,18</sup>

### Recurrent Aphthous Stomatitis:

Recurrent aphthous stomatitis (RAS), a common condition, is characterised by numerous recurrent tiny, round, or oval ulcers with constrained edges. In terms of clinical manifestation, they take the minor, major, or herpetiform form of RAS. They don't have any tissue tags from ruptured vesicles and can be single or many in number. On strongly keratinized gingiva or palates, they are less frequent.

The most popular kind of treatment for canker sores is low-intensity ultrasound. On tissues, USG has a non-thermal action. USG affects the oral microbiota, induces granulation tissue growth, or increases angiogenesis.<sup>19</sup>

### Ultrasound Therapy in Myofascial Pain:

Myofascial trigger points are small, highly sensitive areas of muscle that are characterised by hypersensitive, palpable, and taut bands of muscle that exhibit tenderness on palpation, produce the patient's symptoms, and cause referred pain. Myofascial pain dysfunction syndrome (MPDS) is one of the most common causes of facial pain after tooth ache. Myofascial Pain Dysfunction Syndrome is attributed to pain and inflammation of the masticatory muscles, with no definitive pathogenesis causing this syndrome. MPDS is defined as pain that originates from these trigger points.<sup>20,21</sup> Non-pharmacological and pharmaceutical therapies are used to treat MPDS. The basic therapies for the majority of patients with this illness are education and exercise. When treating myofascial pain and its accompanying symptoms in a patient, adjuvant therapies such medications, physical therapy, dry needling, and trigger point injection may be appropriate. One of the most difficult but worthwhile musculoskeletal pain problems to treat is MPDS. In myofascial pain, therapeutic ultrasound acts by converting electrical energy to sound waves and transmits heat energy to muscles. This improves persistent muscle spasm and relaxes the muscle. Esposito et al. (1984) in his study concluded that ultrasound is most successful in alleviating muscle pain.<sup>22</sup>

## MISCELLANEOUS APPLICATION:

### Ultrasonic Scaler:

Using an ultrasonic scaler, dental ultrasonography is primarily used to remove dental calculus and plaque from the surfaces of teeth. These tools are helpful because they lessen the mechanical effort needed by the physician and operate at frequencies between 25 and 42 kHz. Additionally, they are simple to use, which reduces the patient's suffering as well as the length of the treatment.

The handpiece's transducer, either piezoelectric or magnetostrictive, generates the ultrasonic vibrations. Both versions make use of a flow of cooling water that is applied to the oscillating tip through the handpiece. By reducing frictional heating at the tooth/tip junction, the cooling water helps.<sup>23</sup>

### Endodontic Scaler:

Before starting the filling process, the root canal of a nonvital tooth may be cleaned and prepared using ultrasonic vibrations. These devices are simply a direct adaption of an ultrasonic scaler in which a stiff metal rod is driven to oscillate in its longitudinal mode and a small file is attached close to the end of the main driver and positioned at an angle of between 60° and 90° to the main longitudinal axis. In order to accomplish this, a transverse wave is created along the length of the oscillating file, which is then inserted into the tooth's root canal and used to abrade the walls and remove contaminated organic and inorganic material.<sup>6</sup>

### Ultrasonic Cleaning Bath:

Commercially, ultrasound is frequently used to clean solid objects by submerging them in liquid and then subjecting them to the mechanical impacts of cavitation activity and acoustic microstreaming.

In dentistry, ultrasonic cleaning baths with frequencies ranging from 18 to 100 kHz are used to clean rubber base imprints before to casting, remove lime and stains from dentures, and clean dental instruments before sterilisation.<sup>23</sup>

**Table no. 3:** Advantages and Disadvantages of Ultrasounds in Dentistry<sup>24</sup>

Advantages	Disadvantages
<ul style="list-style-type: none"><li>• It is non-invasive and non-ionizing. Therefore, it can be used repeatedly for as number of times as desired because it has no long-term cumulative effect.</li><li>• It causes a less discomfort and is relatively rapid, and its examination can be performed even at the patient's bedside</li><li>• It has the possibility of real-time imaging</li><li>• It is widely available and relatively inexpensive</li><li>• It is well tolerated by the patient</li><li>• Equipment are portable</li><li>• It does not interfere with normal function</li><li>• It is proven to be reproducible and simple</li></ul>	<ul style="list-style-type: none"><li>• The technique is very operator- and equipment-dependent</li><li>• Ultrasound images are affected by inherent noise accompanying the signal returned to the transducer which makes interpretation of the static images, and sometimes the dynamic ones as well and a non-moving object will vary in appearance because of this noise.<sup>15</sup></li><li>• Ultrasonography waves do not visualize bone or pass through air, which acts as an absolute barrier during both emission and reflection.</li></ul>

## CONCLUSION:

After many years of service in the medical profession, the role of USG in the dentistry area is a subject of considerable research, assisting humanity in understanding its limitless potential in treating a variety of disorders affecting the oral and maxillofacial regions. USG is a noninvasive, extensively used, cheap, and reproducible procedure for both diagnosis and treatment. USG approach has a high operator reliance.

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