REVIEW

ULTRASONICS

(Applications of Ultrasound in Orthodontics)

Pooja Mehta¹, Roshan M Sagarkar², Silju Mathew³, Prashantha G S⁴, Srijan Shilpi⁵

*Corresponding Author Email: mehtapooja181@gmail.com

Contributors:
¹,⁵ Post Graduate students, Department of Orthodontics & Dentofacial Orthopaedics, FDS, MSRUAS, Bangalore
² Reader, Department of Orthodontics & Dentofacial Orthopaedics, FDS, MSRUAS, Bangalore
³ Professor and Head, Department of Orthodontics & Dentofacial Orthopaedics, FDS, MSRUAS, Bangalore
⁴ Professor and Head, Department of Orthodontics & Dentofacial Orthopaedics, FDS, MSRUAS, Bangalore

ABSTRACT

Ultrasound are sound waves with frequencies higher than those audible to humans. They can be used for visualizing subcutaneous body structures including tendons, muscles, joints, vessels and internal organs for possible pathology and lesions. They are also being used for therapeutic purpose. They have been used extensively in various fields of medicine. Ultrasound has been recognized for having several advantages- safe, non-invasive, patient friendly and less expensive approach. But their role in dentistry especially in orthodontics is limited. Ultrasound makes its use both in various areas of diagnosis and therapeutics, but very little importance is given to it in the field of orthodontics.

INTRODUCTION:

In physics, the term “ultrasound” applies to all acoustic energy with a frequency beyond human hearing (20,000 hertz or 20 kilohertz). Although ultrasound was discovered many years before x-rays, its use in medicine was identified much later. The first practical application of ultrasound was recognized during the World War I, for the detection of submarines. The purpose of ultrasound in medicine began in the past century. It was first familiarized in the field of obstetrics, and after that in all the other fields of the medicine including dentistry. The diagnostic ultrasonic devices operate in the frequency range of 2 to 18 megahertz, much higher than the limit of human hearing. There are two types of ultrasound based on the applications and ultrasonic intensities - Diagnostic ultrasound (intensities between 5 – 500 mW/cm²) and Therapeutic Ultrasound (intensities between 1 – 3 W/cm²). Lately ultrasound is widely being used in dentistry for both diagnostic and therapeutic procedures.

ULTRASOUND IN ORTHODONTICS

Ultrasound has made its ways into orthodontics through various ways-
1. Diagnosis of infantile and mature swallow
2. Imaging of condylar position
3. Diagnosis of zygomatic fractures
4. Determining the masseter muscle mass
5. Healing of orthodontically induced root resorption
6. Accelerating orthodontic tooth movement
7. Selection of proper mini-screws in daily clinical practice

1. Diagnosis of infantile and mature swallow

A number of malocclusions are caused due to abnormal tongue posture or the swallowing patterns. It is fairly important to identify the cause of the malocclusion to precisely treat the case. Tongue proportions, posture and function are of great importance in the etiology of malocclusion. The tongue function and posture is quite difficult to examine due to the various structures surrounding
it. Ultrasound can be used for the objective assessment of the tongue. This technology has the potential to be an important part of functional diagnostics before, during and after orthodontic treatment. It helps in differential diagnosis of visceral and somatic swallow, according to a study done by Chien-Lun Peng ultrasonic was used to conclude that movement of the genioglossus muscle could be used as a reliable means to diagnose infantile and mature swallow.¹

2. Imaging condylar position

Nearly 20% of the total cases which have undergone mandibular advancement show relapse after a few years of treatment due to the inability to locate the accurate presurgical position of the TMJ. Ultrasound appears to be a good and accurate imaging technique for guidance in orthognathic surgery. It assists the surgeons to visualize the segment of TMJ and direct it to its presurgical position, as it is considered to be more biologically stable. Ultrasound can be used to assess the soft tissues before and after the surgical procedure. It is quite an efficient way to capture the TMJ position as well as its dynamic properties.²⁻⁴

3. Diagnosis of zygomatic fractures

Ultrasound offers a safe, inexpensive, accurate aid to conventional radiography of the facial bones and is well tolerated by recently injured patients. Many studies have shown up to 85% accuracy in diagnosing fractures of the zygomatico-orbital complex and also the condyle, although it was not accurate enough to replace plain radiography as the principal mode of imaging. Ultrasound may be considered as an alternative to repeating plain films to answer any doubts about configuration or displacement of fractures. The other possible roles of ultrasound may include preoperative assistance in closed reduction of the malar complex. The technique can also be useful when there is a coexisting injury to the cervical spine and also in the assessment of uncooperative patients when CT is impracticable. Ultrasound may be also used to assess the remodelling around the infraorbital foramen, which may be used as a prognostic tool to predict infraorbital nerve recovery but this requires further investigation.⁵

4. Determining masseter muscle mass

Ultrasonography is used to measure the thickness of the masseter muscle. It is found to be a reliable method. The results can be conveniently compared to those obtained with Magnetic Resonance Imaging. Raadsheer et al compared both Ultrasound and MRI in measuring the mid-belly masseter muscle thickness and showed Ultrasound to be a precise and reproducible imaging technique. However, Ultrasound imaging also lets us detect pathological changes in the muscle on the basis of amplified echo intensity.⁶ To study the masseter muscle, water based gel is applied to the probe. The transducer is angled perpendicular to the surface of the skin and special care is taken not to avoid too much pressure. The thickest part of the masseter muscle at the level of the occlusal plane is considered as the ideal site for examination. These measurements and imaging are done bilaterally and carried out with the patient in supine position. The muscle mass is measured under two different conditions-muscle in relaxed position, and during maximum clenching when the muscle is contracted. This measurement would help us to predict the prognosis of functional appliances.

5. Healing of orthodontically induced root resorption

The mechanical stimulus prompts the strong release of inflammatory factors, like the tumor necrosis factor-a (TNF-a), interleukin-b (IL-b), and prostaglandin E2 (PGE2), from the periodontal ligament. These inflammatory factors can elevate the expression of RANKL. LIPUS can reduce the levels of these inflammatory factors, TNF-a and IL-b, thereby reducing RANKL expression and osteoclast differentiation. Treatment with LIPUS increases level of OPG and reduces RANKL expression, thereby reducing the number and activity of osteoclasts and therefore decreasing root resorption.⁶

6. Accelerating orthodontic tooth movement

LIPUS (Low intensity pulsed ultrasound) is a medical technology, using 1.5 MHz frequency pulses, with a pulse width of 200 μs, repeated at 1 kHz, at a spatial average and temporal average intensity of 30 mW/cm², 20 minutes/day. It is used to gently massage the area of interest. It accelerates alveolar bone remodelling, thus causing a potential decrease in orthodontic treatment time. LIPUS stimulation enhances orthodontic tooth movement by elevation of the HGF/Runx2/BMP-2 signalling pathway gene expression and RANKL expression. Because LIPUS is harmless and non-invasive, it would be a promising novel adjuvant therapy for accelerating orthodontic tooth movement, which could result in faster orthodontic tooth movement.⁷⁻⁹

7. Selection of proper mini-screws in clinical orthodontic practice

An ultrasonic gingival-thickness meter can used to quantify the soft-tissue thickness in the buccal-attached gingiva just adjacent to the mucogingival junction of the upper and lower arches. A study by Bong-KuenCha et al, concluded that significantly greater thickness of soft tissue was seen in the upper anterior and lower posterior region. These findings could help clinicians to choose the proper mini-screws with greater ease.¹⁰

CONCLUSION

Ultrasound has revolutionized the world of medicine as a diagnostic and therapeutic aid. Though diagnostic ultrasound has been used as a reliable diagnostic tool in the medical field but has still not found its place as a routine diagnostic aid in the orofacial region. Therapeutic
Ultrasound is also yet not understood well. Nevertheless, most dentists are still oblivious of the full utility of this technology. The findings of this article present the various fields of applications in orthodontics and also some of the advantages of ultrasound in association to traditional modalities; such as non-ionizing radiation, non-invasive method, easy, painless, accuracy, visualization of hard and soft tissue, and good acceptance by patients, which makes it very fascinating and capable of being used in various other specialties as well.

References


