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Therapeutic Applications of Ultrasound in Dentistry

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Abstract:
Ultrasonography (USG) is one of the most common imaging modality used in dental and medical sciences. It is popularly used in these fields as a diagnostic modality nevertheless; it has several applications as a therapeutic aid as well. It is a widely available, affordable and non-invasive treatment method in patients with pain, musculoskeletal disorders, soft tissue swellings, cancers and so on. The aim of this paper is to highlight the therapeutic use of ultrasound (US) in the field of dentistry.
Keywords: Dentistry, Therapeutic Ultrasound (US), Ultrasonography

INTRODUCTION:

In the year 1800s Jacques and Pierre Curie observed that high frequency sound waves can be produced by certain crystals when subjected to an alternating current at their resonant frequency [1]. Paul Langevin in 1926 reported the biological effects of ultrasound. However in the late 1940s Karl Dussik, was the pioneer in the use of ultrasound in the medical field. In the year 1955, it was found that US can remove plaque & calculus from human teeth, and it can be used to treat disorders of the temporomandibular joint (TMJ). In 1990s, several research were published regarding the potential therapeutic effects of US in maxillofacial bone healing [2].Man J et al, in 2012 described the natural impacts of low frequency ultrasound on dental tissues and reasoned that the observed impacts may give a therapeutic means for repairing dental pulp and dentin [3].

Ultrasound was introduced in the field of medicine by its application in therapeutics by utilizing its effect of heat and acoustic cavitation [4]. Dentistry in modern era is emerging with various therapeutic modalities among which ultrasound is most widely accepted and can be used in clinical practice. Nowadays, it is used as an adjuvant therapy for pain, soft and hard tissue healing, inflammation and swelling [5]. US therapy in dentistry is used in treating myofascial pain dysfunction syndrome, temporomandibular disorders, craniofacial fractures, sialolithotripsy of salivary calculi, descaling of teeth, root canal procedures, and osseo-integration in dental implants and in gingival regenerative procedures [6].

PRINCIPLES OF ULTRASOUND:

The ultrasound device generates electrical impulses that are converted into high-frequency ultrasound waves by a transducer, a device that converts one form of energy into another (in this case-electric energy to sonic energy) [7]. The main component of transducer is the piezoelectric crystal (lead zirconate titanium). The electrical impulse from the transducer causes a series of vibrations in the crystal inside that produces the sound waves that are transmitted to the body tissues being examined or treated. The sonic waves reflected towards the transducer produces an electric signal that is amplified, processed, and displayed as an image on a monitor.

MECHANISM OF ACTION OF ULTRASOUND:

The therapeutic effects of ultrasound are attributed to both its thermal and non-thermal properties, which produce a break in pain cycle with increased pain threshold, elevation in the permeability of cell membrane and with elevated vascularity and fluid circulation [8].

Thermal effects (Continuous wave exposure):

At intensities of 1-1.5 watts/cm^2, sound waves cause tissue vibration that creates heat in the primary field. Secondary effects from the production of heat include increased blood flow to tissues, which delivers important nutrients and removes waste. This type of therapy is used in musculoskeletal conditions such as spasm. It is estimated that thermal effects can occur with elevation of tissue temperature to 40-45^0 C for atleast 5 minutes. Thermal effects usually last for 5-10 minutes following treatment. Excessive thermal effects, seen in particular with higher ultrasound intensities, may damage the tissues [8, 9].

Non-thermal effects (Pulsed exposure):

Non-thermal effects of ultrasound include acoustic streaming and cavitation**.** Acoustic streaming is the unidirectional movement of fluid along cell membranes as a result of the ultrasound or mechanical pressure wave pushing fluid past these structures. Cavitation refers to the mechanical pressure waves within the biological fluid by compression and subsequently decompression of microscopic gas bubbles (FIGURE- 1). The propagation of sound waves through the tissues produces a cycle of compression and rarefaction of the exposed tissues [10]

The range of frequency used in therapeutic ultrasound is 0.7-3.0 MHz, whereas diagnostic ultrasound has a frequency of 1-20 MHz [11]. An increase of 1^{0}C (mild heating) over baseline muscle temperature(36.8^{0}C-37.8^{0}C) accelerates the metabolic rate in the tissue, thus a frequency of upto 3MHz with 1.5W/cm^2 and 0.9^{0}C/min is used in US therapy [12]. The intensities used in ultrasound therapy varies between low(<3W/cm^2) to high (>3W/cm^2).

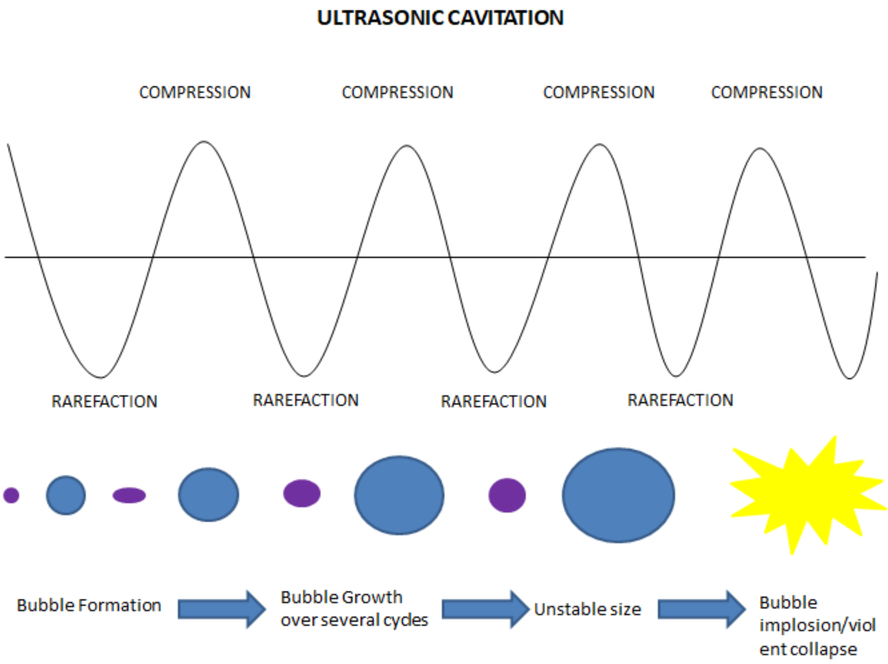

Fig 1- Compression and Rarefaction of microbubbles on ultrasonic cavitation [10]

The purpose of this review is to briefly outline the therapeutic applications of ultrasound in various aspects of dentistry.

ULTRASOUND THERAPY FOR MYOFASCIAL PAIN:

Ultrasound therapy has been largely used in the treatment of myofascial pain syndrome (MPS). The main objective in the treatment is to resolve the spasm, reduce the pain and inactivate the trigger points with its thermal effect, which is brought by increased blood flow in tissues, permeability in membranes and tissue healing. It also increases the ability of collagen fibres to grow [13]. Van der et al, in his study showed that moderate dose of US (0.8-1.5W/cm^2) was effective in the management of myofascial pain [6].

Majlesi et al compared and conducted study on 72 patients with pain in upper trapezius muscle. They gave high power static US in continuous modes, the control group was given conventional US and they concluded that high-power static US technique relieved acute trigger points more rapidly than conventional US technique [14]

Apala et al conducted a study in patient with spasm of the masseter and temporalis muscle, where they used combination therapy (US therapy & transcutaneous electric nerve stimulation therapy). US therapy was given with a frequency of 0.8W/cm^2, followed by TENS therapy. At the end of 2 weeks, there was considerable decrease in pain &episode of spasm [15].

ULTRASOUND THERAPY FOR TEMPOROMANDIBULAR DISORDERS:

Physical therapy is an important therapeutic aid which relieves musculo-skeletal pain, reduces inflammation and restores oral motor function and therefore various physical modalities are potentially effective in the management of TMD's, which include electro physical modalities, exercise and manual therapy techniques. Electro physical modalities include US therapy, microwaves, low-level laser therapy and transcutaneous electric nerve stimulation therapy [16].

Ultrasound therapy uses high-frequency sound waves directed to TMJ, to reduce pain and swelling and improve circulation. Forrest et al demonstrated that a continuous ultrasound delivered at 1MHz to the TMJ at 1.0-1.25W/Cm^2 for 3 minutes is a protocol well-tolerated by patients without any reported side effects [17].

Grieder et al used US therapy in patient with TMD and muscle spasm. They concluded that the benefits of US therapy are higher when used in conjunction with other modalities like acupuncture, muscle exercises, occlusal splinting and heat application [18].

ULTRASOUND THERAPY FOR ORAL SUBMUCOUS FIBROSIS:

Various studies are proposed to study the effect of US therapy in OSMF patients. Ultrasound waves penetrate the skin to cause vibrations in soft tissues and tendons, providing gentle deep tissue heating thus reducing inflammation and pain to accelerate healing in OSMF patients. The objectives of US treatment are to increase the extensibility of collagen fibres and provide pain relief. Guduru et al carried out a study in 33 patients with OSMF where he incorporated the use of dexamethasone and hyaluronidase as intralesional infiltration along with US therapy. They suggested that the US therapy can be given as an adjunct treatment modality in OSMF patients [19].

Himani Tyagi et al compared and conducted study in 30 patients with OSMF. They were given lycopene (12mg/day) and intralesional injection biweekly for 3 weeks and the experimental group was also given therapeutic US with soft tissue mobilization. They concluded that when US therapy used as an adjunct shows a significant improvement in the patient's condition with no reported side effects [20].

Vyoma Bharat dani et al in the year 2018, conducted a study in 20 patients with OSMF, and he observed that US therapy when used in combination with exercises improved mouth opening when compared to exercises alone [21].

ULTRASOUND THERAPY IN HEALING SOFT TISSUE INJURIES:

Therapeutic US are utilized by physical therapists to deliver a high frequency mechanical vibration to facilitate healing at cellular level [22]. The use of low-intensity US in the treatment of tendon, muscle, ligament and tendon-bone junction injuries is supported by the literature. Both *in vivo* and *in vitro* studies show that US can promote tissue repair and wound healing if correctly applied.

The thermal effects of US have shown to play a vital role in tissue healing. The various phases of wound healing include inflammatory phase, proliferative phase, epithelialization phase and remodelling phase. Ultrasound applied during the initial 'inflammatory' phase of tissue repair enhances the degranulation of mast cells resulting in the release of histamine and other mediators thus accelerating the phase. When applied to the 'proliferative' phase, US stimulate fibroblast migration and proliferation to secrete collagen. Applying US during the 'epithelialization' phase stimulates the release of growth factors needed to regenerate epithelial cells. Delivering US during the final 'remodelling' phase increases the collagen extensibility and enzyme activity, therefore improving the tensile strength of the healing tissue. Typically the intensities of US for dermal wounds are 1-1.5W/cm^2 at frequency of 3MHz and for deep laceration it is 0.3-0.5W/cm^2 at frequency of 1MHz [https://www.physio-pedia.com/Therapeutic_Ultrasound].

ULTRASOUND THERAPY IN BONE HEALING AND OSTEOINTEGRATION:

Most studies regarding the effects of US therapy on bone healing have been conducted on long bones; the numbers of studies involving maxillofacial surgeries have been limited [23]. A report by Cavaliere used ultrasound for the first time to enhance maxillofacial bone healing. He applied US at high intensities (1-2W/cm^2) in four patients with mandibular fractures and noted increased callus formation and decreased pain. Application of therapeutic US in maxillofacial bones was also reported by Harris, where he applied US at 3MHz and 1W/cm^2 for 40 days for treatment of osteoradionecrosis of mandible. He found positive progression of neovascularity and neocellularity in the irradiated tissues in 10 of 21 patients.

In recent decades, low-intensity pulsed ultrasound (LIPUS) is used for healing bone fractures and for promoting osteointegration. US waves are used with a frequency of 1MHz-1.5MHz and are given in a pulsatile manner [23]. In implant dentistry LIPUS fastens healing of soft tissues and also promotes osteointegration. Elaf et al, conducted a study in 22 patients, where implants were placed in maxillary premolar region and observed for a period of 6 months [24]. He concluded that there was an increase in the marginal bone level around the dental implant and increase in height & width in the buccal bone plate in the experimental group who received LIPUS in comparison to the control group.

SONOPORATION:

Sonoporation or cellular sonication is defined as the use of ultrasound to temporarily permeabilize the cell membrane allowing the uptake of various substances including DNA, drugs and other therapeutic components from the external environment [25]. This alteration in the membrane leaves the compound confined inside the cell after US exposure.

The sound waves generated from the sonoporator leads to formation of pores in four ways by cavitation effects, thermal effects, induction of connective transport, mechanical effects [26]. There are various sonoporation mechanisms proposed and the main hypotheses of trapped micro-bubble interaction with cells are push and pull mechanisms, microjetting, microstreaming and translation of microbubbles through cells. Sonoporation is commonly used for gene delivery, local & targeted drug delivery, tumour cell killing and induction of apoptosis [27].

The primary issue in conventional drug delivery is systemic toxicity. Sonophoresis (phonophoresis) overcomes this by developing molecular vehicles that can sequester the drug inside a package and release it using US stimulus to the designated site [28]. Sonophoresis is a localised, non-invasive, convenient and rapid method of delivering low molecular weight drugs as well as macromolecules into the skin. Various carriers used for this mechanism include microbubbles, micelles and liposomes. It gains advantage over other drug delivery system since the drug is delivered directly into the targeted area bypassing the hepatic metabolism [29].

Drugs that can be delivered through sonophoresis include NSAIDs, anaesthetics, antibiotics, anticancer drugs, corticosteroids, insulin and vasodilators. These drugs can be incorporated into microbubbles, which targets a specific diseased site. These drugs are released ultrasonically from microbubbles and made to enter into the designated tissue (FIGURE-2). The intensity commonly used for transdermal drug delivery is 0.5-3.0W/cm^2 at frequency 1-3MHz [25].

Transdermal delivery of drugs of much higher molecular weight requires skin permeation enhancement mechansims [29]. Low-frequency US, when applied in combination with enhancers like sulphoxides, azones, alcohols, alkanols, glycols have shown to be more effective than ultrasound alone. These enhancers temporarily alter the barrier properties of stratum corneum that enhances drug flux.

Shankar et al conducted a study in 50 patients with TMJ disorders to determine the efficacy of ultrasonically driven analgesic gel-aceclofenac (phonophoresis). One group received plain continuous ultrasound and the other group received analgesic gel phonophoresis. Both treatment modalities are found beneficial and phonophoresis is further helpful in patients who are sensitive to any systemic form of NSAIDs [30].

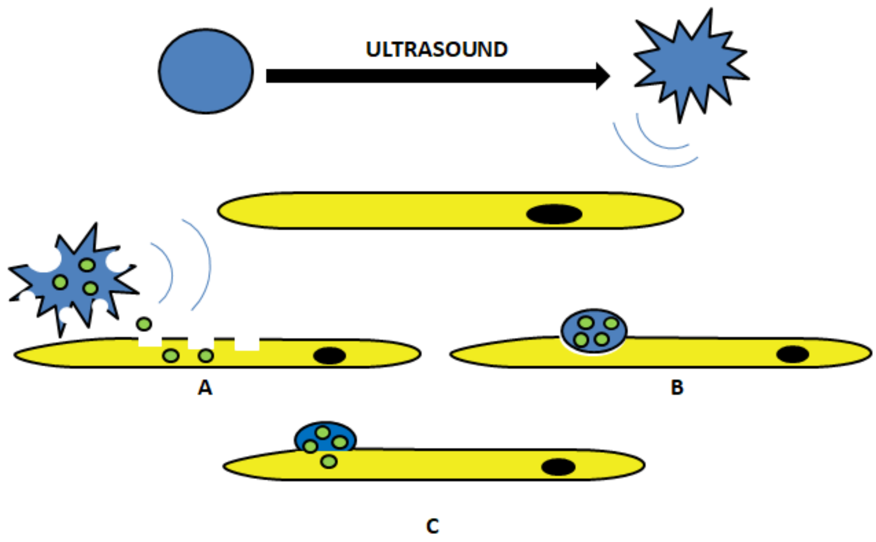

Fig 2- Drugs incorporated microbubbles targeted towards a diseased site [25]

ULTRASOUND THERAPY IN CANCER (SONODYNAMIC THERAPY):

Sonodynamic therapy (SDT) emerged as a approach for the treatment of cancer recently. It is based on the use of low-intensity ultrasound and a molecule called sonosensitizer, that is sonically activated [31]. SDT is derived from photodynamic therapy (PDT), where light is used as an external stimulus to activate a photosensitizer. SDT gains advantage over PDT as it has higher tissue penetration depth where malignant cells reside [32]. SDT retains the ability to produce Reactive Oxygen Species (ROS) in the form of inertial cavitation, which is the process of creating microbubbles in liquid and implode it giving substantial amount of energy that severely damages malignant cells through hydrodynamic shear forces.

SDT combined with chemotherapy is the focused issue in the research of cancer treatment. US can selectively improve the uptake of chemotherapeutic drugs in cancer cells, thus reducing the toxicity to normal cells. Another emerging approach in anticancer field is using combination of SDT & PDT. Miyoshi et al, used Tio_2, 5-ALA as photosensitizer and sonosensitizers in animal tumor model and suggested that it showed strongest anti-tumor effect when used in combination [33].

EXTRACORPOREAL LITHOTRIPSY:

Extracorporeal shockwave lithotripsy (ESWL) is a minimally invasive treatment modality which uses shock waves generated outside the body [34]. It has been used in dentistry for the treatment of sialolithiasis. The purpose of the treatment is to disintegrate salivary stone into smaller particles less than 2mm to flush it out by inducing salivation . It is used for treating sialolith in the parotid and submandibular ducts and the size should be less than 7mm. Pulse frequency of 0.5-2Hz is applied in each session until the stone is fully crushed [35].

ULTRASOUND THERAPY IN NERVE DISORDERS:

Focused ultrasound therapy (High-intensity focused ultrasound)and US guided injectate delivery is an alternative to surgery in patients with trigminal neuralgia (TN). The treatment focuses beams of US energy accurately on targets deep in the brain without damaging surrounding normal tissue. The US produces precise ablation (thermal destruction of tissue) enabling TN to be treated without surgery [https://www.fusfoundation.org/diseases-and-conditions/neurological/trigeminal-neuralgia]. Antoun et al, studied the efficacy of US guided injections of local anaesthesia and steroids in pterygopalatine fossa in patients with TN and concluded that it provides sustained pain relief in patients who have failed previous interventions [36].

Low-intensity ultrasound has been used in the management of bell's palsy. Ayyanniyi et al, applied 0.5-0.8W/cm^2 of ultrasound delivered for 5 minutes by direct contact over the mastoid process on the affected side in 4 of his patients affected with facial palsy biweekly for 4 weeks. He used feldene gel as a couplant which is a NSAID. He observed spontaneous recovery in all his patients [37].

ULTRASOUND GUIDED ABLATION:

Due to advancement in US imaging and image-guided ablation, ultrasound is used in the diseases of cervical lymph node metastases. US-guided radiofrequency ablation (RFA) is a minimally invasive therapy that provides promising results in local tumor control. Wang et al, conducted a study in 8 patients with cervival lymph node metastases after total thyroidectomy due to thyroid carcinoma. They performed RFA procedure with real-time ultrasound guidance and concluded it as a feasible, effective and safe therapy in patients with difficult reoperations since it reduces repeated neck dissections [38].

CONCLUSION:

The application of therapeutic US has been employed for more than three decades with little or no documented evidence of adverse effects. The therapeutic part of ultrasound is becoming more widespread primarily because of the medical and cost benefits that could be realized by the non-invasive nature of the procedure. Thus a resonable amount of palliation is achieved by utilizing the US for therapeutic effect in dentistry either alone or in conjunction with other treatment modalities. The continuing advances in this field may promise exciting developments in the near future.

The advantages of therapeutic US includes that, it is non-invasive, readily available therapy, relatively inexpensive and well tolerated by the patient, performed without sedation, does not interfere with the normal physiology of the body, no known cumulative biological effects, portable equipment [39].

The limitation to US therapy includes the following, if lesion is deeper or surrounding bone is thick, US waves are absorbed by the bone, method is operator dependent, cannot be used in cardiac pacemaker patients, cannot be used in open wounds or active bleeding spots, not to be used in patients with hemophiliacs not covered by factor replacement, in vascular abnormalities including deep vein thrombosis, emboli & atherosclerosis, pain over the treated area, glandular swelling, ductal bleeding after ESWL treatment. [http://www.electrotherapy.org/assets/Downloads/Therapeutic_Ultrasound_2015.pdf].

REFERENCES:

1. William BD, Byong Y, Inhyouk S. Ultrasonic dental therapy. *EIJST* 2013*; 2(1)*: 1-6.
2. Alok A, Singh A, Kishore M, Kumar A. Ultrasonography- a boon in dentistry. *SRM J Res Dent Sci* 2019; *10(2)*: 98-104.
3. Man J, Shelton R, Cooper P, Shheven B. Low-intensity low frequency ultrasound promotes proliferation and differentiation of odontoblast like cells. *J Endodon* 2012; *38(5)*: 608-13.
4. Mago J, Sheikh S, Pallagatti S, Aggarwal A. Therapeutic applications of ultrasonography in dentistry. *J Indian Acad Oral Med Radiol* 2014*; 26(4)*: 414-18.
5. Jose AA, Naveen, Hemant, Jose CM, Kuruvilla A. Therapeutic ultrasound- a new innovative therapy in dentistry. *J Med Pract Rev* 2018*; 2(6)*: 179-84.
6. Kumar S, Rastogi T, Beeraka K, Raju M, Rao S. Ultrasound: a renevant therapeutic modality in dentistry. *J Clin Diagn Res* 2016; *10(7)*: 8-12.
7. White SC, Pharoah MJ. *Oral Radiology- principles and interpretation*. In: Mallya S, Lam E, editors. Advanced imaging: Ultrasonography. 6th ed. Elsevier; 2009. Pp.236-7.
8. Rai S, Kaur M, Goel S, Panjwani S, Singh S. Prospective utility of therapeutic ultrasound in dentistry- review with recent comprehensive update. *Adv Biomed Res* 2012; *1(1)*: 47-54.
9. Koneru J, Alaparthi RV, Yalamanchali S, Reddy S. Therapeutic ultrasound- the healing sound and its applications in oral diseases: a review of literature. *J Orofac Sci* 2012; *4(1)*: 3-6.
10. Lennart D Johns. Non-thermal effects of therapeutic ultrasound: the frequency resonance hypothesis. *J Athl Train* 2002; *37(3)*: 293-99.
11. Xin Z, Lin G, Lei H, Lue Tom F, Guo Y. Clinical applications of low-intensity pulsed ultrasound and its potential role in urology. *Trans Androl Urol* 2016; *5(2)*: 255-66.
12. Draper DO, Castel JC, Castel D. Rate of temperature increase in human muscle during 1 MHz and 3MHz continuous ultrasound. *J Orthop Sports Phys Ther* 1995; *22*:142-50.
13. Aziz M, Kadriye, Goksen. Effectiveness of ultrasound therapy on myofascial pain syndrome of the upper trapezius: randomized, single-blind, placebo-controlled study. *Arch Rheumatol* 2018; *33(4)*: 418-23.
14. Majlesi J, Ulanan H. High-power pain threshold ultrasound technique in th treatment of active myofascial trigger points: a randomized, double-blind, case-control study. *Arch Phy Med Rehabil* 2004; *85*: 833-36.
15. Apala B, Bhuvana K. Treatment of hemifacial spasm in patient with hemifacial atrophy using combination therapy: a case report. *Korean J Pain* 2017; *30(4)*: 304-7.
16. Roopika H, Sunil MK, Chandini G, Anudeep R, Tabiha K, Arishah G. Efficacy of ultrasound massage therapy as an adjunct pain control modality in TMDS: a clinical study. *J Indian Acad Oral Med Radiol* 2018; *30*: 107-9.
17. Forrest LW, James M, Daniel MB, Michael D. Tolerance of ultrasound over the temporomandibular joint. *J Orthop Sports Phys Ther* 1992; *15(5)*: 206-8.
18. Grieder A, Vinton PW, Cinotti WR, Kngaur TT. An evaluation of ultrasonic therapy for temporomandibular joint dysfunction. *Oral Surg Oral Med Pathol* 1971; *31*: 25-31.
19. Guduru H, Galarpati K, Soloman RV, Ignatius AV, Yeladandi M, Madireddy N. A comprehensive study of efficacy of intralesional corticosteroids and hyaluronidase therapy with and without ultrasound therapy in patients with oral submucous fibrosis. *J Indian Acad Oral Med Radiol* 2019; *31*: 11-6.
20. Tyagi H, Lakhanpal M, Dhilon M, Baduni A, Goel A, Banga A. Efficacy of therapeutic ultrasound with soft tissue mobilization in patients of oral submucous fibrosis. *J Indian Acad Oral Med Radiol* 2018; *30*: 349-54.
21. Dani VB, Patel SH. The effectiveness of therapeutic ultrasound in patients with oral submucous fibrosis. *Indian J Cancer* 2018; *55*: 248-50.
22. Dyson M. *Role of ultrasound in wound healing*. In: kloth LC, MC Culloch JM, Feeder JA, editors. Wound healing: Alternatives in management. Philadelphia, PA: Davis, 1990: 259-65.
23. Erdogan E, Esen E. Clinical importance of ultrasound therapy in bone healing. *J Ultrasound Med* 2009; *28*: 765-76.
24. Elaf A, Hamid HE, Marzuki O, Atsuo K, Sugita Y, Fatma A, et al,. The effect of low intensity pulsed ultrasound therapy on osseointegration and marginal bone loss around dental implants. *J Hard Tissue Biology* 2017; *26(4)*: 323-30.
25. Shivani S, Ankit S, Komal G, Sonika S. Sonoporation: therapeutic ultrasonic waves. *Int J Oral Health Med Res* 2016; *3(1)*: 183-88.
26. Priyadarshini K, Nalini A, Aarthi N. Sonoporation- the healing sound and its applications in dentistry. *Res J Pharm Biol Chem Sci* 2014; *5(2)*: 1219-24.
27. Sheikh S, Pallagatti S, Singh B, Kalucha A. Sonoporation, a redefined ultrasound modality as therapeutic aid: a review. *J Clin Exp dent* 2011; *3(3)*: 228-34.
28. Juan J, Dalia BM, Martha Angelica VG, Isabel RC, Clara DD. The use of sonophoresis in the administration of drugs throughout the skin. *J Pharmaceut Sci* 2009; *12(1)*: 88-115.
29. Sivakumar M, Tachi bana K, Pandit AB, Yasui K, Tuziuti T, Towata A, et al,. Transdermal drug delivery using ultrasound theory, understanding and critical analysis. *Cell Mol Biol* 2005; *51*: 767-84.
30. Ramakrishna SN, Aswath N. Comparative effivacy of analgesic gel phonophoresis and ultrasound in the treatment of temporomandibular joint disorders. *Indian J Dent Res* 2019; *30*:512-5.
31. Canavese G, Ancona A, Racca L, Canta M, Dumontel B, Tania L, et al,. Nanoparticle assisted ultrasound: a special focus on sonodynamic therapy against cancer. *Chem Eng J* 2018; *340*: 155-72.
32. Matthew T. Using the promise of sonodynamic therapy in the clinical setting against disseminated cancers. *Chemother Res Pract* 2015;*15*: 1-16.
33. Wan G, Liu Y, Chen B, Liu Y, Wang Y, Zhang N, et al,. Recent advances of sonodynamic therapy in cancer treatment. *Cancer Biol Med* 2016; *13*: 325-38.
34. Capaccio P, Torretta S, Pignataro L, Koch M. Salivary lithotripsy in the era of sialendoscopy. *Acta Otorhinolaryngol Ital* 2017; *37*: 113-21.
35. Anisha Maria, Yogesh S, Deepashri HR. Salivary gland lithotripsy: a non-invasive alternative. *J Sci Res* 2009; *2(1)*: 35-6.

36. Nader A, Kandell MC, Oliveira GS, Jeffry Q, Chen, Vanderby B, Joshua M, et al,. Ultrasound- guided trigeminal nerve block via the pterygopalantine fossa: an effective treatment for trigeminal neuralgia and atypical fascial pain. *J Pain* 2013; *16*: 537-45.
37. Ayanniyi O, Akinpelu O. The use of ultrasound in the management of bell's palsy: a case study. *J Nig Soc physio* 1992; *11*: 31-34.
38. Wang L, Ge M, Xu D, Chen L, Qian C, Shi K, et al. Ultrasonography- guided percutaneous radiofrequency ablation for cervival lymph node metastases from thyroid carcinoma. *J Can Res Ther* 2014; *10*: 144-9.
39. Shubham S, Deepali R, Mohit S, Mansha M. Ultrasound as a diagnostic boon in dentistry- a review. *Int J Sci Stud* 2014; *2(2)*: 70-6.