Ultrasonics : To Treat or To Retreat

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Introduction

Diseases of the investing tissues of the teeth have been documented in the writings through early civilization to date. So has the role of plaque and calculus in the causation of gingival and periodontal diseases. Many of these texts also stress upon the removal of the above mentioned agents in order to restore the health of the periodontium. While the removal of plaque and calculus still remains central to periodontal therapy, the methods of achieving the same have evolved in keeping with the strides in technology. Traditionally root surface debridement has been carried out with hand instruments such as curettes, however the last few decades have seen the advent of power driven instruments as an accepted treatment modality.

Power driven scaler systems may be classified as sonic and ultrasonic scalers.

Ultrasonic Scalers

Dorland's[1] medical dictionary defines the term 'Ultrasonic' as:

"Pertaining to mechanical radiant energy having a frequency beyond the upper limit of perception by human ear, that is, beyond about 20,000 cycles per second (cps/hertz)"

The human ear is sensitive to sound waves in the range of 20-20,000 cps and demonstrates greatest sensitivity within a range of 1,000 to 3,000 cps. Ultrasonic waves used in medical (diagnosis and therapy) and industrial units (communication, sonar detection, cutting extremely hard substances, crystal splitting in transistor manufacturing, dye dispersion etc.) have a frequency of around 2,000,000 cps.[2]

A Brief History of Ultrasonics in Dentistry

The application of ultrasonics dates back to the late 1800s when Sir Francis Galton, an English physicist, introduced a whistle capable of producing high frequency sounds for herding dogs as a signal. Ultrasonics, which were introduced in dentistry in the year 1955 by Balamuth,[3] found their first use in the field of conservative dentistry.

Sweeney,[4] in 1957, demonstrated the use of ultrasonics in cavity preparations by using slurry as a medium. Catuna[5] estimated the time taken for a standard cavity preparation as 10 seconds. This method of cavity preparation, however, had several disadvantages which were summarized by Clark[6] as follows,

- Poor visibility
- Slow cutting
- Rounding of the working tip
- High cost

This spurred the introduction of high speed rotary turbines for tooth preparations, which are still in use, albeit with modifications made over time.

Ultrasonics were initiated into periodontal therapy, in 1957, by Johnson and Wilson[7] who propounded the concept of direct contact of the ultrasonic tip to the tooth surface for calculus removal. Dentsply, in 1958, introduced the Cavitron prophylaxis unit, which was soon followed by other brands such as Unitek, Union Broach and Midwest. Their use was largely restricted to supra - gingival scaling due to the bulky working tips. However, the recent probe - like slender instrument tips allow for efficient instrumentation of deep periodontal pockets with increased patient comfort and less operator fatigue.

Mechanism of Ultrasonic Scalers

The development of the ultrasonic energy used in dental units is based on one of the two concepts,

(a) Magnetostrictive effect

(b) Piezoelectric effect

Magnetostrictive effect - was discovered by James Prescott Joule when he observed that certain ferromagnetic metals would change their length under the influence of a magnetic field.

In ferromagnetic instruments, the polarity of the magnetostrictive stack is continually altered. When the stack has a positive and a negative pole, the opposite ends of the stack attract each other causing a shortening in length. As the polarity changes the stack reverts to its

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original size. This phenomenon produces 25,000 contractions and expansions per second giving rise to ultrasonic waves Magnetostrictive ultrasonic scalers (e.g. Dentsply, Cavitron, Odontosson) which were introduced in the 1950s are either driven by a meta stack consisting of nickel-iron alloy strips or a ferrite insert placed into a hand-piece. The hand-piece consists of a live coil of copper wire around a plastic cylinder which generates an alternating electromagnetic field, on application of an alternating current. This leads to an expansion or contraction of the ferromagnetic material which forms the transducer (insert) when placed in this magnetic field. The resulting vibrations are conducted to the scaler tip, causing oscillations with amplitudes of 13 to 72 microns and an elliptical motion pattern at frequencies of 20,000 to 45,000 Hz. Thus, depending upon the angulation of the scaler tip in relation to the root surface a more or less pronounced hammering or scraping motion pattern will result.

Piezoelectric effect - was discovered by Pierre Curie, where by he was able to produce positive and negative charges on the surface of quartz crystals under pressure. Conversely, if electrical energy is applied across a piezoelectric substance, measurable changes in length are noted. These constant changes in length will produce ultrasonic vibrations and their energy can be applied to dental procedures.

Piezoelectric scalers (e.g. Amdent, EMS Piezon Master, Satellec Suprasson) also oscillate with frequencies of 20,000 to 45,000 Hz. The vibration is generated by changes in the dimension of a quartz crystal caused by the application of an alternating current. The resulting oscillation mode of the piezoelectric scaler is strictly linear with amplitudes upto 72 microns. The mode of action of the tip is either of a scraping or tapping nature depending upon the direction of the scaler tip towards the root surface.

Ewen and Sorrin,[8] in 1964, provided the literature on the basic prophylaxis unit. The unit consists of a generator which converts the 60 Hz, 120 volt current into a high frequency current, which is then applied to the magnetostrictive stack. Older units consisted of generators with vacuum tubes, while the newer ones are solid state generators. Early models which were manually tuned have now been replaced by auto-tuned newer models of ultrasonic units.

The molecular realignment of the transducer in ultrasonic scalers generates heat and a water flow system is required for heat dissipation, as well as to provide medication to the diseased site when required. As the water flows through the instrument tip, there is dispersion or atomization of the water stream. Within the water droplets of this spray are tiny vacuum bubbles that quickly collapse releasing energy in a process known as *'cavitation'*.[3] The cavitating water spray also serves to flush calculus, plaque and debris dislodged by the vibrating tip, from the pocket. A flow rate of least 14 ml/min to 23 ml/min of cooling irrigation fluid appears to be sufficient to prevent thermal damage in periodontal pockets.[9]

Sonic Scalers[9]

The other variety of oscillating scaler systems consists of Sonic scalers.

Sonic scaler hand-pieces were invented during the 1960s (e.g. Densonic scaler, Titan S, Ka Vo Sonicflex). These operate via compressed air from the dental unit. A rotating cam within the instrument hand-piece generates vibrations with frequencies in the range of 6,000 to 9,000 Hz. The vibrations are conducted to the scaler tip, which then oscillates, depending upon the air pressure input, with an amplitude of upto 1000 microns in an almost circular/orbital motion. This oscillatory pattern removes plaque and calculus by a tapping motion regardless of the adaptation of the tip to the root surface (i.e. mesial, distal or buccal). Herein lies one of the major advantages of sonic scalers over ultrasonic scalers. Sonic units do not generate heart as ultrasonic do, but they still have water for cooling and flushing away debris.

Indications and Contraindications for Power Driven Scaling

Indications and contraindications of ultrasonic scaling are not substantially different from those of hand instruments in both initial and supprotive periodontal therapy.

Slim sonic and ultrasonic tips may lend themselves more easily to debridement in furcation areas as opposed to conventional curettes. The use of sonic and ultrasonic instruments in patients with transmissible diseases[9] should be strictly avoided as the aerosol and splatter caused by these units can pose a potential health hazard for the dental personnel. Pre-procedural antiseptic rinse prior to supra-gingival scaling may reduce the microbial content of the resultant aerosol, but sub-gingival scaling procedures always result in the dispersion of blood. Thus, splatter and aerosol might be contaminated with pathogenic micro-organisms. A high volume evacuator may be used to minimize the aerosol dispersion. Magnetostrictive scalers may interfere with cardiac pacemakers and hence must not be used in affected patients.[9]