Sonic and Ultrasonic Instrumentation and Irrigation

Power-Driven Instruments:

Introduction

Power instruments are useful tools that can be used alone or in combination with hand instruments. Power-driven instruments are everyday mainstays in periodontal therapy and maintenance.

* Evidence indicates that power-driven instruments provide clinical outcomes similar to those derived from hand instruments.

* Power instrumentation has the potential to make scaling less demanding and more time efficient.

*Potential hazards from using power-driven devices include rough root surfaces, production of bioaerosols, and interference with cardiac pacemakers.

Mechanism of Action of Power Scalers

Various physical factors play a role in the mechanism of action of power scalers. These factors include **frequency**, **stroke**, and **water low**. In addition to the rate of flow, the physiologic effects of water may contribute to the efficacy of power instruments.

Water contributes to three physiologic effects that play a role in efficacy. These are **acoustic streaming**, **acoustic turbulence**, and **cavitation**.

Acoustic steaming is a unidirectional fluid flow caused by ultrasound waves.

Acoustic turbulence is created when the movement of the tip causes the coolant to accelerate, producing an intensified swirling effect. This turbulence continues until cavitation occurs.

Cavitation is the formation of bubbles in water caused by high turbulence. The bubbles implode and produce shock waves in the liquid, thus creating further shock waves throughout the water. In vitro, the combination of acoustic streaming, acoustic turbulence, and cavitation has been shown to disrupt biofilm.

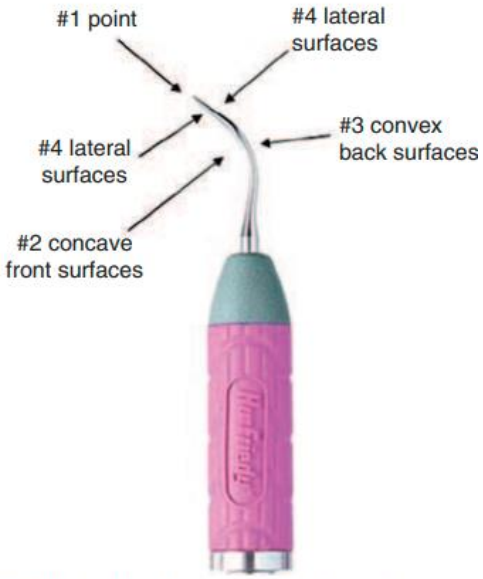
Type and Benefit of Power Instruments

Sonic units work at a frequency of 2000 to 6500 cycles per second and use a high- or low-speed air source from the dental unit. Water is delivered via the same tubing used to deliver water to a dental handpiece. Sonic scaler tips are large in diameter and universal in design. A sonic scaler tip travels in an elliptical or orbital stroke pattern. This stroke pattern allows the instrument to be adapted to all tooth surfaces.

Ultrasonic scalers convert electrical current into mechanical energy in the form of high-frequency vibrations at the instrument tip; the vibration frequencies range from 18000 to 45000Hz and an amplitude range of 10–100µm

Magnetostrictive ultrasonic devices work in a frequency range of 18,000 to 50,000 cycles per second. Metal stacks that change dimension when electrical energy is applied power the magnetostrictive technology. Vibrations travel from the metal stack to a connecting body that causes the vibration of the working tip. Tips move in an elliptical or orbital stroke pattern. This gives the tip four active working surfaces.

A magnetostrictive ultrasonic device.



Working sides of a magnetostrictive tip.

Piezoelectric ultrasonic units work in a frequency range of 18,000 to 50,000 cycles per second. C eramic disks located in the handpiece power the piezoelectric technology and change in dimension as electric energy is applied. Piezoelectric tips move primarily in a linear pattern, giving the tip two active surfaces. Various insert tip designs and shapes are available for use.

A piezoelectric ultrasonic device.

Working sides of a piezoelectric tip.

Advantages and Disadvantages of Mechanized Instruments Compared With Manual Instruments

Advantages

1. Increased efficiency
2. Multiple surfaces of the tip are capable of removing deposits
3. No need to sharpen
4. Less chance for repetitive stress injuries
5. Large handpiece size
6. Reduced lateral pressure
7. Less tissue distention
8. Water
9. Lavage
10. Irrigation
11. Acoustic microstreaming

Disadvantages

1. More precautions and limitations
2. Client comfort (water spraying)
3. Aerosol production
4. Temporary hearing shifts
5. Noise
6. Less tactile sensation

7. Reduced visibility

Clinical Outcomes of Power-Driven Instruments

Numerous clinical outcomes have been evaluated from the use of power-driven instruments.

* The studies have found the effectiveness of subgingival debridement using ultrasonic or sonic scalers to be similar to that achieved with hand instruments.

*It is well established that power-driven instruments remove bacterial biofilm and calculus through mechanical action. With the advent of newer designs and thinner tips, deplaquing of root surfaces may be effectively accomplished by power scalers.

* Power-driven instruments are effective in removing calculus, similar to hand instrumentation. Ultrasonic instruments, through high-speed action, produce cavitational activity and acoustic microstreaming that some believe may help enhance the disruption of bacteria in subgingival biofilm

*The primary expected clinical outcomes from scaling and root planing are reductions in bleeding and probing depth and a gain in clinical attachment. Comparing power scalers with hand instruments, both types demonstrate similar outcomes for reductions in bleeding on probing and probing depth and gains in clinical attachment.

*Because the opening of a furcation is narrower than with conventional hand instruments, power scalers may be recommended as a means to improve access when scaling this type of defect

Indications for Use of Mechanized Instruments

1. Supragingival debridement of dental calculus and extrinsic stains
2. Subgingival debridement of calculus, oral biofilm, root surface constituents, and periodontal pathogens
3. Removal of orthodontic cement
4. Gingival and periodontal conditions and diseases
5. Surgical interventions
6. Margination (reduces amalgam overhangs)

Precautions for Use of Mechanized Instruments

1. Unshielded pacemakers
2. Infectious diseases: human immunodeficiency virus, hepatitis, tuberculosis (active stages)
3. Demineralized tooth surface
4. Exposed dentin (especially associated with sensitivity)
5. Restorative materials (porcelain, amalgam, gold, composite)
6. Titanium implant abutments unless using special insert (e.g., Quixonic SofTip Prophy Tips)
7. Children (primary teeth)
8. Immunosuppression from disease or chemotherapy
9. Uncontrolled diabetes mellitus

Contraindications for Use of Mechanized Instruments

1. Chronic pulmonary disease: asthma, emphysema, cystic fibrosis, pneumonia
2. Cardiovascular disease with secondary pulmonary disease
3. Swallowing difficulty (dysphagia)

Special Considerations

Power-driven instruments must be used with some caution. Roots may be rougher post-scaling than with hand instruments. Due to aerosol production, proper infection control procedures need to be implemented. Power-driven instruments may be contraindicated for people with pacemakers.

Root Surface Roughness

The data are mixed on whether power-driven instruments cause more root surface roughness than hand instruments. Although it could be assumed that using the device at a higher power may cause more roughness, this is not been proven. It is also not known how much root surface roughness affects the healing process. Powerdriven instruments may increase the roughness of resin or glass ionomer restorative materials; **therefore, repolishing post-scaling is recommended**

Aerosol Production

Power-driven devices produce bioaerosols and splatter, which can contaminate the operator and remain in the air for up to 30 minutes. Good infection control practices can minimize the hazard. Data have shown that preprocedural rinsing with 0.12% chlorhexidine and high-speed evacuation are the most efficient ways to reduce bioaerosols.

(Bioaerosols from power-driven devices can remain in the air for up to 30 minutes. If the operator's face mask becomes damp during the procedure, it should be changed. A face shield may be required. To help minimize bioaerosols, preprocedural rinsing and high-speed evacuation be effective.)

Cardiac Pacemakers

The use of ultrasonics on patients with cardiac pacemakers is somewhat controversial. Newer models of pacemakers often have bipolar titanium insulation that is believed to make ultrasonic and sonic instruments generally safe for use. An in vivo study supports this; 12 patients underwent continuous electrocardiogram monitoring during piezoelectric ultrasonic scaling and had no abnormal pacemaker functions. Conversely, an in vitro study found that ultrasonic scalers interfered with the activity of dual-system pacemakers. If in doubt, consult with the physician regarding any precautions or warnings from the manufacturer of the product.

Principles of Instrumentation

The ultrasonic technique is different from instrumentation with hand scalers. A pen grasp is used with an ultrasonic scaler, along with an extraoral fulcrum.

The purpose of the extraoral fulcrum is to allow

the operator to maintain a light grasp and have

easier access physically and visually to the oral cavity.

Alternate cross-arch or opposite-arch fulcrums are

acceptable alternatives.

Pen grasp of tip.

Light pressure is needed with a power instrument. The tip is traveling at a set frequency in a set stroke pattern. **Increased clinician pressure on the tip causes decreased clinical efficacy**.

Sonic or ultrasonic instrumentation requires removal from the coronal to the apical portion of the deposit. This stroke pattern allows the insert to work at its optimal stroke pattern and frequency for quick, effective deposit removal. For coronal deposits located in the embrasure area, a horizontal or transverse tip orientation is recommended.

A deplaquing stroke should be used when the focus is the removal of biofilm and soft debris for the resolution of gingival inflammation. This stroke entails accessing every square millimetre of the tooth surface during ultrasonic deplaquing as a result of the limited lateral dispersion of the lavage subgingivally.

Power driven device and infectious disease

The aerosol produced by sonic and ultrasonic instrumentation may contain potentially infectious blood-borne and airborne pathogens. Pneumococci, staphylococci, α-hemolytic streptococci, and Mycobacterium tuberculosis are among the bacteria that have been found in dental aerosols. Aerosols also subject dental personnel and patients to many viruses, including herpes simplex, hepatitis, inluenza, common cold, Epstein-Barr, and cytomegalovirus.

Aerosol from ultrasonic instrumentation always contains blood, and it lingers in the air for 30 minutes or longer in the entire operatory and in areas of the dental office outside the operatory. Unprotected patients may be more susceptible to infection from the aerosol than are dental personnel who are wearing protective barriers, such as masks, gloves, eyewear, and clinical clothing. Highspeed evacuation, preprocedural rinsing with chlorhexidine, flushing of the handpiece and water lines or a self-contained sterile water source, thorough disinfection of environmental surfaces, and use of adequate ventilation and air filtration units with high-eficiency particulate air (HEPA) filters are all important precautions to minimize the potential hazards of ultrasonic aerosols

Home and Self-Applied Irrigation

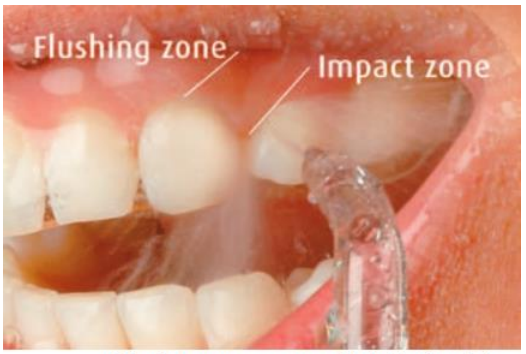
The oral irrigator (also called a dental water jet or water flosser) was introduced in 1962. Contrary to myth and misunderstanding, the body of evidence on this device has consistently shown that it safely and effectively improves periodontal health. Emerging evidence indicates that the oral irrigator effectively removes bioiflm and is as effective as dental floss when added to toothbrushing.

A cordless dental water jet, which also has 1200 ppm.

Mechanism of Action of Irrigation

The mechanism of action of irrigation is through pulsation and pressure. Pulsation creates a decompression phase that allows the water or solution to penetrate subgingivally. It is followed by a compression phase that expels bacteria and debris from the pocket

Physiologically, pulsation, along with pressure and water velocity creates shear hydraulic forces that are capable of removing bacterial biofilm from treated areas.



Pulsation creates two zones of hydrokinetic activity: the impact zone and the flushing zone.

Clinical efficacy home irrigation has been found for units that pulsate from 1200 to 1400 pulses per minute set at a minimum of 60 psi.33

(Pulsation and pressure create a compression-decompression phase that allows for both penetration of the agent into the sulcus or pocket and expelling of bacteria and debris. Unlike simple rinsing, pulsation, pressure, and water velocity create shear hydraulic forces capable of removing biofilm.)

A variety of tips can be used with an oral irrigator.

One type of tip is placed supragingivally at a 90-degree angle and the other is placed slightly subgingivally. Tips placed above the gingival margin result in a pocket penetration of 50% on average.

Jet tip.

The soft, site-speciic subgingival tip (Pik Pocket subgingival irrigation tip, Water Pik penetrates to about 90% of the depth of pockets that are 6 mm or less and 64% of pockets that are 7 mm or greater.

Site-specific tip.

Tips that are placed supragingival are recommended for full-mouth irrigation or cleansing. These tips include a traditional jet tip along with jet tips of this configuration that has been enhanced with bristles or filaments to assist in biofilm removal.

Tip with soft tapered bristles.

Tip with soft filaments.

The subgingival tip is generally used after full-mouth cleaning for localized irrigation of a specific site that is difficult to access, such as

a deep pocket, a furcation, an implant, or a crown

and bridge.

The Pik Pocket tip is gently placed slightly subgingivally

Individuals With Special Considerations

Some clinical trials have focused on groups with special oral or medical health needs.

-Both children and adults undergoing orthodontic therapy have shown significant benefits from using a dental water jet. A newer small brush tip that cleans and irrigates simultaneously has been shown to remove 3.76 times more plaque than brushing and flossing with a floss threader.

-For individuals with implants, a modified jet tip with filaments is both safe and effective. Patients who used the oral irrigator at 60 psi with warm water had twice the reduction in bleeding around implants compared with patients who used floss. No adverse events were reported. The site-specific subgingival tip has also been shown to be safe and effective for use on implants.

- The oral irrigator has also been found to improve periodontal health in people with type 1 or 2 diabetes.

- For patients who prefer natural products, subjects who used the oral irrigator for 30 days post scaling and root planing effectively reduced the clinical parameters of periodontitis and periodontal bacteria similar to scaling and root planing followed by the placement of 1 mg of minocycline hydrochloride. Any differences between the two therapies were not statistically significant.