Efficiency and Effectiveness in Ultrasonic Scaling

A Peer-Reviewed Publication
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Earn 4 CE credits
This course was written for dentists, dental hygienists, and assistants.

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Educational Objectives
Upon completion of this course, the clinician will be able to do the following:
1. Understand the importance of biofilm and calculus removal.
2. Identify the advantages of ultrasonic scalers compared to hand scalers.
3. Understand the types of power scalers available and their modes of action, as well as considerations in selecting a power scaler and in selecting clinically-appropriate inserts and tips for individual cases.
4. Identify the ergonomic advantages and recent advancements in ultrasonic scalers.

Abstract
The standard non-surgical treatment for periodontal disease is supra- and subgingival scaling to disrupt and thoroughly remove biofilm, calculus deposits, periodontal pathogens, and debris. Considerations in the choice of method include efficacy, efficiency, safety, patient comfort, and ergonomics. The latest generation of ultrasonic scalers offers the ability to thoroughly instrument deep pockets and furcation areas, and offers benefits over conventional hand scalers which include improved operator ergonomics and comfort, improved patient comfort, less tooth substance removal and more efficient and effective treatment.

Introduction
Periodontal disease relies upon the presence of a mature biofilm rich in periodontopathogens, and is evident to varying degrees in the majority of U.S. adults. The progression of periodontal disease is highly variable and dependent largely upon the host response, with bacterial variances between individuals accounting for only 20% of cases progressing. Nonetheless, the removal of bacteria and their by-products is essential to prevent and halt periodontal disease. Within 48 hours of dental biofilm formation, sufficient numbers of periodontopathogenic anaerobes are established for the onset of gingivitis. Left undisturbed, three to twelve weeks later a complex subgingival biofilm that is highly structured and contains mainly gram-negative anaerobes will have developed. Mature biofilm both harbors and protects bacteria by enveloping them in a resistant biofilm, with the deepest regions harboring the most periodontopathogens and exhibiting the highest levels of bacterial vitality. The reversible gingivitis which develops 48 hours after biofilm formation will transform to an active process whereby the host releases antibodies, neutrophils, lymphocytes, and macrophages into the adjacent tissue. The production of cytokines, prostaglandins, and chemokines leads to inflammation and bone loss.

Dental calculus is present in the majority of adults supra- and subgingivally, and is 70%-80% inorganic. Calculus formation results from calcification of dental biofilm and exfoliated oral epithelial cells. The mineral ions responsible for this originate in the saliva and additionally from the crevicular fluid. In addition, dental calculus contains bacterial debris interspersed within a mineral deposit of mainly calcium phosphate. Research has found that supragingival calculus also has nonmineralized areas within it containing bacteria. Endotoxins are slowly released from dental calculus into the adjacent soft tissue, where they may become destructive to the soft and hard tissues of the periodontium.

Once a mature subgingival biofilm has developed, or dental calculus is present, clinical intervention is required — typically carried out by non-surgical periodontal treatment.

Goals of Non-Surgical Periodontal Treatment
The overall goals of periodontal treatment are to halt disease progression and to obtain clinical attachment gains. Supra- and subgingival scaling is the standard non-surgical treatment for periodontal disease, and may be supplemented with adjunctive therapy. The objectives of scaling are to disrupt the dental biofilm and to remove the maximum possible amount of dental biofilm, dental calculus, periodontal bacteria, and debris from the root surfaces and soft tissue. A further objective is that the root surfaces be biocompatibility, smooth upon completion of scaling, thereby reducing the risk of recolonization and subgingival biofilm adhesion and retention. (As clarification — root planing is not indicated, and is both clinically unnecessary and damaging to the root surface integrity.) Clinically, definitive removal of dental calculus is important. Retained dental calculus provides a distinct raised or rough site for bacteria adhesion and for biofilm retention, and will also contain endotoxins (Table 1).

Table 1. Goals of Non-Surgical Periodontal Treatment

<table>
<thead>
<tr>
<th>Benefits</th>
<th>Halt Disease Progression</th>
<th>Clinical Attachment Gains</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Disruption of dental biofilm</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Removal of dental biofilm</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Removal of dental calculus</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Removal of periodontal bacteria and debris</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Smooth root surfaces upon completion of scaling</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Supra- and subgingival scaling can be performed with hand instruments or with power scalers. An alternative is a blended procedure using both hand instruments and power scalers. Considerations in the choice of method include efficacy, efficiency, safety, patient comfort, and ergonomics. The use of hand scalers requires great care to achieve a satisfactory result, and takes a considerable amount of time. It is now generally held that hand scalers and ultrasonic scalers are similar in their effectiveness in removing subgingival biofilm. However, standard Gracey curettes are known to be too wide to enter the furcation in more than half of all maxillary and mandibular first molars, which have furcation entrances as narrow as 0.63 mm wide while the minimum width of the Gracey curettes is 0.76 mm. Hand scalers have been found to be ineffective in removing calculus deposits in furcation areas whether an open- or closed-flap technique is used. Ultrasonic scalers are considered superior to hand instruments for the treatment of moderate and severe furcations.
The precision thin tips of ultrasonic scalers are significantly thinner than the working ends of curettes, enabling them to enter narrow furcation areas. A further difference exists between hand scalers and ultrasonic scalers with respect to their positioning for calculus removal (Table 2). Hand scalers, such as curettes, must be apical to the deposit prior to its removal, while with ultrasonic scalers the insert is positioned coronal to the deposit — resulting in easier application of the instrument and potentially less tissue distension. Hand instruments also appear to cause more root surface damage than ultrasonic scalers used at a medium power setting. Jacobson et al. found that using hand scalers resulted in grooves and cementum removal evident with SEM analysis, while the use of ultrasonic scalers resulted in no detectable changes to the root surface. Recently, lasers have been used for scaling and root planing procedures, and while effective in removing calculus deposits, in vitro testing found the Er:YAG laser to be less efficient than ultrasonic scalers and the root surface was found to be structurally altered with the development of a surface microroughness after lasing.

Table 2. Comparison of Hand Scalers and Ultrasonic Scalers

<table>
<thead>
<tr>
<th></th>
<th>Hand Scalers</th>
<th>Ultrasonic Scalers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Minimum width of tips</td>
<td>0.76 mm</td>
<td>0.55 mm</td>
</tr>
<tr>
<td>Slim inserts available</td>
<td>Yes — less than ultrasonic slim tips</td>
<td>Yes</td>
</tr>
<tr>
<td>Positioning of tips</td>
<td>Apical to the deposit</td>
<td>Coronal to the deposit</td>
</tr>
<tr>
<td>Deposit removal in furcations</td>
<td>Less effective</td>
<td>More effective</td>
</tr>
<tr>
<td>Lavage</td>
<td>None</td>
<td>Low to moderate</td>
</tr>
<tr>
<td>Patient comfort</td>
<td>Varies with clinical skill, tips used</td>
<td>Varies with clinical skill, tips used</td>
</tr>
<tr>
<td>Root surface damage</td>
<td>More than with ultrasonic scalers</td>
<td>Less than with hand scalers</td>
</tr>
<tr>
<td>Ergonomics</td>
<td>More wearing, fatigue</td>
<td>Less wearing, fatigue</td>
</tr>
<tr>
<td>Bacterial aerosol</td>
<td>If irrigation is used</td>
<td>Yes, minimize</td>
</tr>
</tbody>
</table>

Hand instrumentation requires highly repetitive and complex hand movements, which can be wearing. Ultrasonic devices have enabled clinicians to effectively and efficiently remove hard deposits and subgingival biofilm. When selected and used appropriately, they are clinician and patient friendly, and offer ergonomic benefits over hand scaling. Ultrasonic scaling also reduces the time required for thorough scaling compared to hand scaling, increasing efficiency for the office by reducing the time patients must sit in the dental chair.

Types of ultrasonic scaling devices

The first stand-alone ultrasonic scalers were introduced in the 1950s. Since then ergonomically designed devices and tips, microtips, microprocessor controls, and other innovations have been introduced. Ultrasonic devices are available in the U.S. as magnetostrictive devices and as piezoelectric devices (Figure 1). These are mechanically distinct in their mode of action and method of use. In the U.S., the best known and most used is the magnetostrictive ultrasonic scaler.

Magnetostrictive ultrasonic scalers rely upon an elliptical movement of the insert tip. The magnetostrictive stack in the insert converts energy from the handpiece into mechanical oscillations that activate the tip (Figure 2). The electronic system produces small strokes of the insert that are microscopic and delivers from 25,000 to over 40,000 cycles (strokes) per second at the tip. A second type of magnetostrictive device that is less common (Odontoson) uses a ferrite rod to produce a rotational rather than elliptical movement. Ultrasonic devices are available with closed loops that automatically adjust the tuning for the resonance of each tip, enabling the clinician to successively insert different tips into the handpiece without having to adjust settings each time.

The insert must be meticulously adapted to all areas of the tooth surface. It is important to note that the most active area of the insert’s tip is the point, followed by the concave face of the insert, then the convex back, with the lateral surfaces being the least active. The point of the insert should never be directed into the tooth surface, and care should be taken that the face of the insert is not adapted perpendicular to the tooth’s surface. The majority of scaling will be accomplished with the back and lateral surfaces of the insert. The length of the active tip area for scaling depends upon the energy output and frequency at which the ultrasonic unit operates. Magnetostrictive ultrasonic scalers operate at a frequency ranging from 18 to 45 kHz, typically at 25 or 30 kHz. At a frequency of 25 kHz, the terminal 4.3 mm of the tip is active, while at 30
kHz, 4.2 mm of the tip is active (Table 3). A higher frequency of 50 kHz results in an active area in the terminal 2.3 mm of the tip.\textsuperscript{22} The inserts should be activated prior to insertion into the pockets and used with a continual stroking motion in a horizontal, vertical, or oblique manner — offering the clinician flexibility and choice. It is important to keep the tip moving and to maintain the integrity of the contact between the active area of the tip and the tooth surface for optimal results. Other important factors in tip use are the amount of lateral force applied — which should be light — and the angulations of the tips themselves to ensure that they are maintained against the tooth surface. Magnetostriuctive technology results in all surfaces of the insert being active. Since all four surfaces of the inserts are used for scaling, magnetostriuctive ultrasonic technology offers more flexibility in adaptation to the tooth surface and technique, as well as ease of use.

<table>
<thead>
<tr>
<th>Frequency</th>
<th>Active Tip</th>
</tr>
</thead>
<tbody>
<tr>
<td>25 kHz</td>
<td>Terminal 4.3 mm</td>
</tr>
<tr>
<td>30 kHz</td>
<td>Terminal 4.2 mm</td>
</tr>
<tr>
<td>50 kHz</td>
<td>Terminal 2.3 mm</td>
</tr>
</tbody>
</table>

The thoroughness with which scaling devices are used is a key attribute for success. If the insert is applied incorrectly to remove biofilm and calculus, the tooth surface may be damaged. As with hand instruments, if inserts are not used properly the removal of biofilm and calculus will not be definitive and will compromise the clinical results and the achievement of the goals of therapy. Studies comparing a sonic instrument (Periosonic), magnetostriective ultrasonic (Cavitron\textsuperscript{8}, Slimline inserts), and hand curettes have shown that all three were effective in disrupting biofilm and in removing biofilm and calculus deposits. Use of the magnetostriective ultrasonic scaler resulted in the least tooth substance loss.\textsuperscript{23} It is well recognized that residual calculus is difficult to detect — one study estimated that 77% of surfaces with residual calculus had been scored as calculus-free.\textsuperscript{24} This can occur regardless of the type of instrumentation used, and is also dependent upon individual clinical expertise. To ensure that calculus is removed and that it is not burnedished, appropriate tips must be selected and used at the correct power setting based on patient need. Magnetostriective ultrasonic units are available that are designed to definitively remove calculus at low to moderate power settings, and some incorporate a power booster which can momentarily increase the power by up to 25% without further altering the device’s settings. These features result in thorough biofilm and calculus removal, while increasing patient comfort and ergonomics for the clinician.

**Piezoelectric ultrasonic scalers** rely upon linear movement, utilizing aligned ceramic discs to produce the straight micromovements of the tip through alternating expansion and compression of the ceramic discs when electricity flows over the surfaces of the crystal (Figure 3). Piezoelectric ultrasonic units operate at a frequency ranging from 25 to 50 kHz. Given the linear fashion in which the tip moves, the tip’s two lateral surfaces are most active. If adaptation to the tooth’s surface is incorrect the tip will sound different against the tooth, letting the clinician know that the tip adaptation needs to be altered. Deposit removal should be accomplished by utilizing the lateral surfaces of a piezoelectric insert. Clinicians must develop definitive techniques to maximize efficiency. The tip must be held lateral to the tooth surface, which is often achieved by pivoting the wrist. While clinical results are similar to those obtained with the use of magnetostriective devices, the limitations of active surfaces afforded by a piezoelectric scaler make it a much more technique-sensitive device. Without successful technique, the clinical outcome of piezoelectric scaling may be compromised — potentially resulting in root surface damage and incomplete deposit removal. In the same vein, clinicians using magnetostriective units should take care not to limit their instrumentation to the tip’s lateral surfaces.

**Comparison of Magnetostriective and Piezoelectric Ultrasonic Units**

The use of either magnetostriective or piezoelectric ultrasonics requires great care and an overlapping movement around the whole of the root surface to ensure biofilm and calculus removal. One in vitro study comparing ultrasonic scalers and hand curettes found that while the piezoelectric device resulted in slightly faster instrumentation compared to the magnetostriective device, both were more efficient than hand curettes. The tooth surface was smoother after use of the magnetostriective device, both were more efficient than hand curettes. The tooth surface was smoother after use of the magnetostriective device and rougher following use of the piezoelectric device. In comparing all three instrumentation methods, the hand curette produced the smoothest surface but the most tooth substance loss as measured by SEMs, and the magnetostriective produced the least tooth substance loss.\textsuperscript{25} The efficacy of calculus removal from a root surface was found to be the same with all three methods.

In comparing magnetostriective and piezoelectric devices, both require the adaptation of tips at the correct angle and continuous motion of the tip when against the tooth helps prevent discomfort. In this regard, adaptation is more versatile with the magnetostriective ultrasonic inserts, which are active on four rather than two surfaces (Table 4). Similarly, it is important to use only a very light grasp and pressure. One study compared pain perception in patients treated with either
a magnetostrictive ultrasonic unit (Dentsply) or a piezoelectric unit (Vector). The patients’ perception of pain was similar during and after treatment, irrespective of the ultrasonic unit used. It should be noted that pain may be associated with tissue distension/manipulation or dentinal hypersensitivity rather than with the movement of ultrasonic tips. Tissue distension can be minimized through careful selection of tips and technique. The use of locally delivered topical anesthetics (Oraqix, Dentsply) or local anesthetics may be necessary, and peri-operative use of desensitizing agents helps relieve hypersensitivity during treatment.

Table 4. Comparison of Magnetostrictive and Piezoelectric Ultrasonic Units

<table>
<thead>
<tr>
<th>Feature</th>
<th>Magnetostrictive Units</th>
<th>Piezoelectric Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mechanism</td>
<td>Metal stack or ferrite rod</td>
<td>Aligned ceramic discs</td>
</tr>
<tr>
<td>Tip movement</td>
<td>Elliptical</td>
<td>Linear</td>
</tr>
<tr>
<td>Active surfaces</td>
<td>Back, face, and lateral (4)</td>
<td>Lateral (2)</td>
</tr>
<tr>
<td>Positioning of tips</td>
<td>Flexible</td>
<td>Must be lateral to surface</td>
</tr>
<tr>
<td>Slim inserts available</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Inserts that mimic perio probe</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Effective calculus removal</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Coolant/lavage volume</td>
<td>Low to high, directional with some inserts</td>
<td>Low to moderate</td>
</tr>
<tr>
<td>Patient comfort</td>
<td>Varies with clinical skill, tips used</td>
<td>Varies with clinical skill, tips used</td>
</tr>
<tr>
<td>Technique sensitive</td>
<td>+</td>
<td>+++</td>
</tr>
<tr>
<td>Learning curve</td>
<td>+</td>
<td>+++</td>
</tr>
<tr>
<td>Flexibility of technique</td>
<td>+++</td>
<td>+</td>
</tr>
</tbody>
</table>

The cavitational effect of ultrasonic devices aids biofilm removal, and the acoustic effects of the water lavage assist in calculus removal. Similarly, the lavage obtained from power-driven scalers’ water/fluid coolant provides for continual flushing and is believed to be of therapeutic benefit. While lavage is considered beneficial, a balance is desirable — with overzealous lavage, the potential for patient gagging and patient discomfort increases and a longer treatment time is required as the amount of suctioning necessary increases. Generally, piezoelectric ultrasonic units use less water than magnetostrictive ultrasonic units. To decrease the fluid necessary for proper lavage production, innovations in magnetostrictive insert designs have allowed for minimal fluid volume and a more focused spray delivered through the insert and tip itself — enabling better visibility, more directional control, increased patient comfort and a decreased need for suction while still providing the beneficial effects of lavage.

**Ultrasonic tip and insert designs**

Originally, ultrasonic tips were available only with extremely limited design options. By the 1990s the clinical limitations of bulky tips were recognized and magnetostrictive inserts designed to improve subgingival and furcation access were introduced. Slim tip inserts are designed to be approximately 30% slimmer than standard insert — this results in improved access (in particular to the depths of pockets greater than 4 mm depth) and also improves patient comfort by reducing tissue manipulation and distension.

In one study in the early 1990s, hand instruments failed to adequately reach the base of deep pockets on 75% of root surfaces, primarily due to the impediments imposed by pocket morphology. However, the base of deep pockets is where higher levels of periodontal pathogens are found. Slim tips available for both magnetostrictive and piezoelectric ultrasonic units are designed to reach into deep pockets effectively and safely. They are able to improve pocket access by 1 mm over hand instrumentation, and to reach the base of 86% of pockets 3 to 6 mm deep. Slim tips designed to mimic the ends of periodontal probes enable easier insertion and improved tactility and enable detection of remaining or residual calculus, saving time by decreasing instrument exchange during treatment.

When compared to the original cumbersome tip designs, the slimmer inserts decrease the amount of tooth surface that is lost to instrumentation. In one study, slim scaler tips were found to produce less substance loss for both magnetostrictive slim tips (Slimline) and piezoelectric slim tips (Perioprobe). Dentin loss was assessed for both types of slim scaler tips using laser profilometry for depth, width, and volume of defects. The magnetostrictive device resulted in less gouging than the piezoelectric device, with mean changes in the dentin of 254.4 microns, 6.3 microns and 22.5 cubic microns for width, depth and volume versus 352.0 microns, 12.1 microns and 56.4 cubic microns respectively (Table 5). It was also found that for both devices, changing the force used from 0.3N to 0.7N increased the substance loss twofold, underscoring the importance of using a light to moderate instrumentation force.

Table 5. Dentin Loss Using Slim Tips: MR and PZE

<table>
<thead>
<tr>
<th>Feature</th>
<th>Slim Tips (MR unit)</th>
<th>Slim Tips (PZE unit)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Width (in microns)</td>
<td>254.4</td>
<td>352</td>
</tr>
<tr>
<td>Depth (in microns)</td>
<td>6.3</td>
<td>12.1</td>
</tr>
<tr>
<td>Volume (in cubic microns)</td>
<td>22.5</td>
<td>56.4</td>
</tr>
</tbody>
</table>

Flemmig et al. studied slim tip inserts using a piezoelectric ultrasonic scaler and compared instrumentation using varying angulations, lateral forces, various power settings,
and instrumentation time. It was found that lateral force most influenced the total amount of root substance loss, while tip angulation had the most effect on the depth of the defect. The greatest defect depth and volume loss occurred when the angulation of instrumentation measured was 45 degrees with 2N lateral force applied. The study concluded that “to prevent severe root damage it is crucial to use the assessed scaler at a tip angulation of close to 0 degrees.”33 In a separate study assessing root substance loss using slim tip inserts in magnetostrictive ultrasonic units, Flemmig et al. again found that the greatest influence on the volume of tooth surface lost to improper instrumentation was the lateral force applied. Angulations of 0, 45, and 90 degrees were used. Unlike the results in the piezoelectric study, severe root damage was not evident when the angulation was 45 degrees, 0.5N lateral force, and the power was set at up to a medium setting. This study concluded that “the efficacy of the assessed magnetostrictive ultrasonic scaler may be adapted to the various clinical needs by adjusting the lateral force, tip angulation, and power setting.”34

As ultrasonics have evolved, new designs in straight and curved tips have included complementary designs reflecting the site-specific benefits of Gracey curettes (Figure 4). By using both right and left inserts in deeper pockets (>4 mm deep) the full circumference of the root, complex root anatomy and furcations can be more easily and properly instrumented (Table 6). Right and left tip inserts are designed to adapt to the root surface and furcation areas for optimal results, with each of these used in specific areas of the mouth and teeth — similar to Gracey curettes. When entering the furcation, rotating the insert enables the tip to reach the roof of the furcation (Figure 4). The importance of superior access and adaptation in deep pockets or furcations cannot be underestimated. Periodontal treatment failure for molars with furcation involvement is more than double the rate of failure for molars with no furcation involvement over an eight-year period.35

Other insert tips include diamond-coated ultrasonic tips. Some manufacturers have designed and advocate diamond-coated tips for non-surgical scaling. Other manufacturers advocate these tips specifically for difficult-to-remove calculus during open-flap procedures, and not for use with non-surgical scaling. Incorrect use of diamond-coated ultrasonic tips can lead to tooth substance loss and soft tissue damage. Teflon-coated tips have been tested and, while effective in disrupting and removing biofilm, were found to be less effective in removing calculus than conventional ultrasonic tips.36

**Instrumentation sequence**

As with hand instruments, different ultrasonic inserts are designed for specific tasks (Table 8). Standard inserts are not intended for use in deep pockets nor are they designed for root adaptation in deep pockets, and should not be regarded as a universal insert. Utilizing appropriate ultrasonic inserts in the correct sequence and at the appropriate power level ensures good clinical results, comfort for the patient and an ergonomic dental hygiene procedure (Table 9, Figure 5). In general, supragingival calculus deposits should be removed using a standard diameter insert at a low to high power setting as indicated by the patient’s oral condition. Following use of standard diameter inserts, debridement of pockets 4 mm deep or greater is achieved using slim tipped inserts at a low power setting. Recent magnetostrictive innovations allow use of lower power settings for thorough calculus debridement. The final stage of the scaling procedure is the use of a slim insert at a low power setting to remove the smear layer on the root surface.

**Ergonomics**

The primary objective of ergonomics is to prevent work-related injuries.37 Scaling involves pinch-grasp, force, vibratory stimuli (if ultrasonic scalers are used), and potentially awkward operator positions.38 Occupational risks specific to delivering dental hygiene care include reduced tactile sensitivity, carpal tunnel syndrome, neck and back injuries, and hand and finger injuries due to muscle fatigue.39,40

Scaling ergonomically requires a number of considerations. Selecting a position for the patient that is comfortable for clinician and patient alike — usually seating the patient at a 45-degree angle — is the first step; this angle should be adjusted as necessary. Similarly, instead of a cli-
nician bending his or her neck and back, it is important to have the patient turn his or her head to the right or left and lift the chin up or down to improve access and visibility to awkward areas — this will save time and result in less fatigue and wear for the clinician without compromising the patient’s comfort or the treatment outcome.

The use of finger rests or fulcrum points helps reduce the thumb pinch force and reduces hand muscle load while utilizing hand instruments. Extra-oral and/or hand-on-hand fulcrums are recommended with ultrasonics to assist with flexibility of movement. Beyond these simple steps, the ergonomics of scaling is mostly influenced by technique and instrument selection.

When hand scaling, it has been found that tactile sensitivity is reduced in as little as 45 minutes. In contrast, using ultrasonic scalers resulted in increases in tactile sensitivity, and vibration was insufficient to reduce this.

Handle instrument design influences hand muscle load and pinch force. Lightweight hand instruments with larger-diameter handles have been found to reduce muscle load and pinch force when compared to heavy or thin-handled instruments. Thicker handle insert designs that incorporate a thick, soft, and dimpled rubber-like handle on the insert are available to improve clinician comfort (Figure 6).

Softer and fatter grips also enable easier rotation and reduce hand fatigue, without affecting the wrist pivot required to position tips properly during piezoelectric instrumenta-

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**Table 8. Insert Tips and Function**

<table>
<thead>
<tr>
<th>Scaler Insert Tip</th>
<th>Use</th>
</tr>
</thead>
<tbody>
<tr>
<td>Standard</td>
<td>Removal of moderate-heavy deposits</td>
</tr>
<tr>
<td>Standard triple-bend</td>
<td>Aids access for removal of moderate-heavy deposits</td>
</tr>
<tr>
<td>Beavertail</td>
<td>Removal of heavy deposits and stains; anterior teeth</td>
</tr>
<tr>
<td>Chisel</td>
<td>Anterior teeth and premolars; overhanging margins</td>
</tr>
<tr>
<td>Perio probe</td>
<td>Shallow and deep pocket deposit removal</td>
</tr>
<tr>
<td>Slim tips</td>
<td>Deposit removal in pockets 4 mm deep and greater</td>
</tr>
<tr>
<td>Straight</td>
<td>Superficial deposit removal</td>
</tr>
<tr>
<td>Curved and angulated</td>
<td>Aid access and adaptation</td>
</tr>
<tr>
<td>Curved right and left</td>
<td>Aid access and adaptation to root morphology; furcation areas</td>
</tr>
<tr>
<td>Right and left furcation</td>
<td>Deposit removal in root furcation areas</td>
</tr>
<tr>
<td>Fine-tipped</td>
<td>Aid access for deposit removal in narrow interdental spaces</td>
</tr>
<tr>
<td>Diamond-coated</td>
<td>Depends upon manufacturer</td>
</tr>
<tr>
<td>Endodontic</td>
<td>Debridement of canals; removal of fractured endodontic instruments</td>
</tr>
</tbody>
</table>

**Table 9. Sequence for Instrumentation**

- **Standard Inserts**
  - Removal of gross, superficial deposits
  - Suitable for pockets up to 3 mm deep
  - Medium–high power setting

- **Slim Tip Inserts**
  - Debridement of pockets 4 mm and deeper
  - Lower power setting
  - +/- hand instrumentation

- **Slim Tip Inserts**
  - Removal of smear layer from root surface
  - Low power setting

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Figure 5a. Standard Diameter Insert With Triple-Bend for Removal of Moderate-Heavy Deposits

Figure 5b. Insert With a Fine Tip for Use in Areas With Narrow Access

Figure 5c. Insert That Mimics the Shape of a Periodontal Probe Provides for Good Access Into Pockets
tion. Originally, ultrasonic handpieces were static and did not pivot during instrumentation. Magnetostrictive units are now available with handpieces with swivel features, reducing discomfort, minimizing line pinching, and enabling instrument manipulation in areas of difficult access (such as furcations and distal root areas). Recent innovations in magnetostrictive ultrasonic units include the incorporation of a remote frequency wireless foot control — this enables the foot control position more flexibility, since it is not tied to the unit by a cord. This offers ease of use and ergonomic benefits since the clinician can position the foot control in the most comfortable position without needing to consider any cords (Table 10).

Figure 6. Insert With Soft, Dimpled Handle

### Table 10. Ergonomics and Influencers

| Neck and back strain, fatigue/ wear | Patient and operator positioning Wireless foot controls |
| Tactile sensitivity | Diminished by hand scaling Increased by ultrasonic scaling |
| Hand pinch/muscle load problems, discomfort | Reduced by use of finger rests/fulcrum points Reduced by use of lighter handles and inserts Reduced by use of fatter inserts and handles Reduced by use of softer grips on inserts |
| Wrist pivot issues | Reduced by use of handpieces with swivel features |

### Implant care

As dental implants continue to evolve into a routine dental procedure, the need for improved scaling instruments and devices is increasing. Long-term implant failure due to peri-implantitis occurs commonly in patients with poor oral hygiene and who do not attend periodic maintenance visits. Meticulous home care and regular clinical maintenance visits are essential to prevent peri-implantitis. Inflammation of the implant site must be kept to a minimum through soft- and hard-tissue deposit removal while minimally impacting the surrounding tissues and the implant. This includes the removal of biofilm and calcified deposits at the implant site and on the implant surface. Instrumentation strategies used in cleaning implant(s) must ensure that the instruments used are compatible with the implant surface. Instrument damage due to inappropriate instrumentation increases the likelihood of biofilm formation and maturation, anaerobic colonization, and calculus formation.

Metal tip hand scalers, including titanium alloy and stainless steel curettes, and metal ultrasonic tips, have been found in studies to result in implant surface roughness and to increase the surface roughness of titanium abutments (Table 11). In addition, it has also been found that HA-coated and plasma-coated implants are more susceptible to surface alterations during scaling than non-coated implants.

Plastic scaling instruments have been found to be safe for use around implants and abutments, and not to increase the surface roughness of the titanium. Sato et al. concluded that ultrasonic inserts with non-metal tips were suitable for implant maintenance. In vitro research using scanning electron microscopy found that use of disposable plastic tips over metal base tips left virtually no traces and did not destroy the surface integrity of implants and abutments.

Systems are available that use metal bases on specialty ultrasonic inserts with a single-use soft plastic tip that fits over the metal base (Cavitron® SofTip™, Dentsply Professional) (Figure 7). These plastic tips are designed to effectively remove biofilm and light calculus deposits at implant sites as well as on the implants and superstructures, without damaging the implant’s surface or affecting the integrity of the peri-implant mucosal cuff.

### Summary

The standard non-surgical treatment for periodontal disease is supra- and subgingival scaling to disrupt and thoroughly remove biofilm, calculus deposits, periodontal pathogens, and debris. Instrumentation options include hand scalers and ultrasonic scalers. Ultrasonic scalers available include both magnetostrictive and piezoelectric units, with the magnetostrictive ultrasonic unit being more frequently used. Scaling inserts have evolved to include slim, complimentary curved right and left, straight, beavertail and angled insert tips as well as specialty instruments, inserts, and tips designed for safe and effective implant care. The latest generation of ultrasonic scalers offers the ability to thoroughly instrument deep pockets and furcation areas, and offers benefits over conventional hand scalers including improved operator ergonomics and comfort, improved patient comfort, as well as more efficient and more effective treatment.

### References

8. Tan B, et al. A preliminary investigation into the ultrastructure of dental calculus and associated...

Author Profile

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Ms. Betsy Reynolds has been a practicing hygienist for over twenty years and has been involved with several private practices stressing comprehensive periodontal care for patients seeking treatment. Betsy has reinforced her love of the microbiological aspects of periodontal therapy by maintaining teaching positions emphasizing the dental sciences at numerous dental and hygiene schools.

Betsy lectures extensively nationally and internationally on subjects that include biologic basis for disease prevention, advanced instrumentation technique, current dental therapeutic modalities, pharmacological considerations for the dental professional, microbiological and immunological aspects of dental disease, the impact of oral disease on systemic health, evidenced-based decision-making and scientific developments affecting oral health care delivery. Additionally, she has authored numerous articles and book chapters on a variety of oral healthcare concerns. Betsy holds a Master of Science Degree in Oral Biology from the University of Washington.

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Questions

1. The removal of ______ is essential to halt and prevent periodontal disease.
   a. bacteria
   b. pellicle
   c. crevicular fluid
   d. none of the above

2. Dental calculus contains calcified ______.
   a. biofilm
   b. exfoliated oral epithelial cells
   c. saliva
   d. a and b

3. Overall goals of non-surgical periodontal treatment are ______.
   a. to halt disease progression
   b. to reduce bleeding
   c. to obtain clinical attachment gains
   d. a and c

4. Hand scalers have been found to be ineffective in removing calculus in ______.
   a. narrow interproximal areas
   b. furcation areas
   c. mesial root surfaces
   d. all of the above

5. Furcation entrances can be as narrow as ______.
   a. 0.45 mm
   b. 0.63 mm
   c. 0.75 mm
   d. 0.92 mm

6. Ultrasonic scalers are considered superior to hand scalers in ______ furcations.
   a. all
   b. moderate and severe
   c. wider
   d. no

7. Ultrasonic scalers are available as ______.
   a. magnetostrictive units
   b. piezoelectric units
   c. supersonic units
   d. a and b

8. Elliptical movement is obtained using ______.
   a. a piezoelectric device
   b. a piezomechanical device
   c. a magnetostrictive device
   d. a and c

9. Piezoelectric ultrasonic units use ______ to convert energy.
   a. ceramic rods
   b. ceramic discs
   c. metallic discs
   d. any of the above

10. The majority of scaling using magnetostrictive ultrasonic inserts will be accomplished with ______.
    a. the point
    b. the face
    c. the lateral and convex back surfaces
    d. the face and lateral surfaces

11. The available active area in the terminal part of ultrasonic inserts depends upon ______.
    a. the frequency at which the ultrasonic scaler operates
    b. the length of the insert
    c. the force applied using the insert against the tooth
    d. none of the above

12. Slim tip inserts are designed to be approximately ______ than standard inserts.
    a. 20% slimmer
    b. 30% slimmer
    c. 15% shorter
    d. none of the above

13. An important factor in tip use is ______.
    a. to keep the tip moving continually
    b. to apply a light lateral force
    c. to angle the tip to ensure that it is against the tooth surface
    d. all of the above

14. False negatives for the presence of residual calculus have been found in up to ______ of root surfaces.
    a. 45 percent
    b. 55 percent
    c. 77 percent
    d. 83 percent

15. Piezoelectric ultrasonic units rely upon what type of movement?
    a. Rotational
    b. Elliptical
    c. Linear
    d. all of the above

16. With piezoelectric ultrasonic units, ______ surfaces of the insert's tip are the most active.
    a. all
    b. the lateral
    c. the front and back
    d. only the back

17. Hand curettes have been found to be less efficient in scaling procedures than ______.
    a. irrigation
    b. magnetostrictive ultrasonic scalers
    c. piezoelectric ultrasonic scalers
    d. a and c

18. In a study comparing magnetostrictive and piezoelectric ultrasonic scaling, patients' perception of discomfort was found to be ______.
    a. similar
    b. very different
    c. less with piezoelectric ultrasonic scaling
    d. less with magnetostrictive ultrasonic scaling

19. Tissue distension can be minimized by ______.
    a. technique
    b. careful selection of tips
    c. a and b
    d. local anesthesia

20. The cavitational effect of ultrasonic scalers aids ______.
    a. biofilm removal
    b. bacterial resistance
    c. saliva production
    d. a and b

21. Reducing the amount of water sprayed from inserts ______.
    a. can improve visibility
    b. can improve patient comfort
    c. reduces the need for suction
    d. all of the above

22. Patient comfort varies with ______.
    a. the specific insert tips used
    b. clinical skill
    c. the patient's ability to sit upright
    d. a and b

23. The flexibility of scaling technique is greatest with ______.
    a. piezoelectric ultrasonic units
    b. magnetostrictive ultrasonic units
    c. lasers
    d. a and b

24. The efficacy of magnetostrictive ultrasonics can be adapted by adjusting ______.
    a. tip angulation
    b. lateral force
    c. power setting
    d. all of the above

25. The full circumference of deep pockets and root morphology can be properly instrumented using ______.
    a. beavertail inserts
    b. right and left inserts
    c. straight inserts
    d. any of the above

26. Standard-size straight ultrasonic inserts are designed for ______.
    a. moderate to heavy deposit removal in probing depths less than 4 mm
    b. deposit removal in pockets deeper than 6 mm only
    c. biofilm removal only
    d. a and b

27. Debridement of pockets 4 mm deep or greater is achieved by ______.
    a. using straight inserts and a low power setting
    b. using slim tip inserts and a high power setting
    c. using slim tip inserts and a low power setting
    d. a or b

28. Implant surface roughness can result from the use of ______.
    a. stainless steel curettes
    b. titanium alloy curettes
    c. chlorhexidine mouthrinses
    d. a and b

29. Disposable plastic tips designed for specialty implant inserts have been found to ______.
    a. safely and effectively remove deposits
    b. disturb the integrity of the implant site
    c. be ineffective
    d. b and c

30. Compared to hand scalers, benefits of the latest ultrasonic scalers include ______.
    a. improved patient comfort
    b. improved operator ergonomics
    c. more effective treatment
    d. all of the above
EDUCATIONAL OBJECTIVES
1. Understand the importance of biofilm and calculus removal.
2. Identify the advantages of ultrasonic scalers compared to hand scalers.
3. Understand the types of power scalers available and their modes of action, as well as considerations in selecting a power scaler and in selecting clinically-appropriate inserts and tips for individual cases.
4. Identify the ergonomic advantages and recent advancements in ultrasonic scalers.

COURSE EVALUATION
Please evaluate this course by responding to the following statements, using a scale of Excellent = 5 to Poor = 0.

1. Were the individual course objectives met?  
   Objective #1: Yes No  
   Objective #2: Yes No  
   Objective #3: Yes No  
   Objective #4: Yes No

2. To what extent were the course objectives accomplished overall?  
   5 4 3 2 1 0

3. Please rate your personal mastery of the course objectives.  
   5 4 3 2 1 0

4. How would you rate the instructor's effectiveness?    5 4 3 2 1 0

5. How do you rate the author's grasp of the topic?   5 4 3 2 1 0

6. Please rate the instructor's effectiveness.  
   5 4 3 2 1 0

7. Was the overall administration of the course effective?  
   5 4 3 2 1 0

8. Do you feel that the references were adequate?  
   Yes No

9. Would you participate in a similar program on a different topic?  
   Yes  No

10. If any of the continuing education questions were unclear or ambiguous, please list them.

11. Was there any subject matter you found confusing? Please describe.

12. What additional continuing dental education topics would you like to see?

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