Hand Vs Ultrasonic Instrumentation: A Review
Anirban Chatterjee†, Baiju C. S††, Somik Bose†††, Sonia.S.Shetty††††, Rohan Wilson†††††

† Professor, Periodontology and Implantology, Oxford Dental College and Hospital, Bangalore, Karnataka, India.
†† Professor and Head, Department of Periodontology and Implantology, Sudha Rustagi Dental College, Faridabad, Haryana.
††† PG student, Periodontology and Implantology, Oxford Dental College and Hospital, Bangalore, Karnataka, India.
†††† PG student, Periodontology and Implantology, Oxford Dental College and Hospital, Bangalore, Karnataka, India.
††††† PG student, Periodontology and Implantology, Oxford Dental College and Hospital, Bangalore, Karnataka, India.

ABSTRACT: The main aim of periodontal therapy is to arrest periodontal infection and maintain a healthy periodontium and the periodic mechanical removal of subgingival microbial biofilms is essential for controlling inflammatory periodontal disease. Mechanical periodontal therapy consists of scaling, root planing and gingival curettage. The hand instruments and ultrasonic scalers are valuable tools in the prevention of periodontal disease. The vibration of scaler tips is the main effect to remove the deposits from the dental surface, such as bacterial plaque, calculus and endotoxin. However, constant flushing activity of the lavage used to cool the tips and cavitation activity result in disruption of the weak and unattached subgingival plaque. Thus the aim of the study was to review the safety, efficacy, role and deleterious side-effects of hand instruments and ultrasonic scalers in mechanical periodontal therapy.

INTRODUCTION
Periodontal therapy aims at arresting periodontal infection and maintaining a healthy periodontium. The first step of periodontal treatment is removing bacterial deposits and calculus from the tooth surfaces and obtaining a biologically acceptable root surface while protecting the healthy dental tissues. Basic periodontal treatment aims at eliminating supra- and subgingival plaque and establishing conditions, which will allow effective self-performed plaque control.

In the past, this aim was primarily realized with handheld instruments (sickle, curettes, chisel, files and hoes) until sonic and ultrasonic scalers were designed for gross scaling and removal of supragingival calculus and stains.

Mechanical debridement consisting of scaling and root planing is an important procedure in the treatment of periodontal diseases. By root instrumentation, toxic substances can be removed from periodontally affected root surfaces resulting in the biologic/detoxic condition of the root surface, which is favorable for periodontal tissue healing.

MANUAL INSTRUMENTS
Manual instruments are generally classified into five types: sickle, curette, file, hoe, and chisel types. In recent years, the sickle and curette types are the most commonly used.

Curette type scalers are more frequently used now than before. There are two basic types of curettes: universal and Gracey curette. Initially, Gracey curettes were available as a set of 14 instruments, but now mainly double-ended Gracey curettes (7 instruments) are used. File type scalers are used to fracture or to crush calculus. This group includes a set of four scalers, for buccal, lingual, mesial and distal sites. The blade is narrow and used for access to deep and narrow pockets. Hoe scalers are used for removal of subgingival calculus, and are a set of four scalers similar to the file type. They can be used for root planing and to remove calculus from the base of the pocket. Chisel scalers, designed for proximal surfaces, are usually used in the anterior part of the mouth and therefore, the adaptation area is limited.

POWER-DRIVEN INSTRUMENTS
Ultrasonic and sonic scalers are referred to as power-driven scalers. High vibrational energy generated in the oscillation generator is conducted to the scaler tip, causing vibrations with frequencies in the range of 25 000-42 000 Hz. The amplitude ranges from 10 to 100 μm. Microvibration crushes and removes calculus under cooling water. Ultrasonic and sonic scalers vary in their efficiency in removing calculus from the tooth surfaces. Discomforting stimuli elicited from their use may include pain, vibration, excessive noise, bad taste and high volume of water coolant.

Sonic scalers are air-turbine units that operate at low frequencies ranging between 3000 and 8000 cycles per second (Cps). Tip movement and the effect of root surfaces can vary significantly depending on the shape of the tip and type of the sonic scaler. In general, tip movement is orbital. Sonic scalers provide a simple and inexpensive mechanism (811). Sonic scalers have a high intensity noise level because of the release of air pressure needed for movement of the tip of the sonic hand-piece.
attached to a scaling tip. When an electrical current is supplied to a wire coil in the hand-piece, a magnetic field is created around the stack or rod transducer causing it to constrict. An alternating current then produces an alternating magnetic field that causes the tip to vibrate. Tip movement is elliptical.

Piezoelectric units operate in the 25 00050 000 Cps range and are reactivated by dimensional changes in crystals housed within the hand-piece as electricity passed over the surface of the crystals. The resultant vibration produces tip movement that is primarily linear in direction.

OTHER INSTRUMENTS

Apart from the abovementioned types, there are instruments mounted on air turbines or microengines. Rotosonic scalers are mounted on an air turbine. A hexagon pyramid-shaped bur on the air turbine removes calculus with rotational movement. Diamond points with fine diamond particles are also used. However, due to excessive removal of tooth substance the use of Rotosonic scalers and diamond points is limited. The instruments mounted on microengines are mainly used for professional toothcleaning. This group includes the rubber cup, brush, prophy cup, EVA tip, etc.

EFFECTIVENESS

Manual and ultrasonic scalers have been reported to be equally effective in subgingival plaque removal. Oosterwaal et al. investigated the effects of manual and ultrasonic scaling (Cavitron _ with TFI-10 tip) on the subgingival microflora in periodontal pockets with a probing depth of 69 mm. They concluded that both treatments equally reduced the microscopic counts of rods, spirochetes, and motile organisms, and reduced the total colony-forming units and number of blackpigmented anaerobic rods and Capnocytophaga. Copulos et al. also reported similar bacteriological observations after manual and ultrasonic scaling (Cavitron _ with modified tip 17.5 mm long and having a shaft width of 1.1 mm). Bachni et al. compared the effects of ultrasonic (Piez-Z-Master_ with type A tip) and sonic (Titan-S_ with Perio tip type no. 56420) scaling on the subgingival microflora, and reported no difference in microscopic or culture observations.

Busslinger et al. found that the calculus remaining was similar after removal by a magnetostriective ultrasonic scaler (Cavitron Jet SPS with Slimline insert), a piezoelectric ultrasonic scaler (Sonosoft with prototype modified insert from KaVo Innovations-GmbH; Biberach, Germany) and a hand curette (a new M23A universal hand curette; Deppeler, Rolle, Switzerland) in vitro. Therefore, it may be concluded that manual and power-driven scalers are equally effective in removal of plaque bacteria and calculus.

EFFECTIVENESS IN ELIMINATION OF VIRULENT SUBSTANCES

The changes to an exposed root surface, especially exposed cementum, have been extensively reported since 1960. These changes include alterations in the levels of calcium or phosphate, degradation of collagen fibers, decalcification of the surface of cementum, hypercalcification, and absorption of bacterial toxins, such as endotoxin.

In 1982, Daly et al. reported the penetration of microorganisms to the depth of the cementodental junction, and suggested that all periodontally involved cementum should be removed during root planing to achieve a root surface free of bacterial contamination. However, in the same year, Nakib et al. immersed healthy teeth in an endotoxin solution and examined the extent of penetration of endotoxin into cementum by indirect immunofluorescence examination. They concluded that endotoxin adheres to the tooth surface without penetration into cementum of either periodontally healthy or diseased teeth, and binding of the endotoxin to the root surface appears to be weak.

Other investigators have suggested that extensive root planing is not essential for endotoxin removal from the root surface. Oda investigated the extent of endotoxin penetration into 57 extracted periodontally involved teeth. Following plaque and calculus removal, exposed root surfaces were scaled with a universal curette in 13 strokes. Root debris after the first two strokes (the first layer), another three strokes (the second layer), the following four strokes (the third layer) and the final four strokes (the fourth layer) were collected to measure the endotoxin contents of each layer. Results indicated that the first layer contained 7.424 times more endotoxin than other layers. He concluded that two scaling strokes with a sharp manual scaler were enough to eliminate endotoxin from periodontally involved root surfaces. Moore et al. investigated the distribution of lipopolysaccharide on periodontally involved root surfaces. They showed that 39% of the lipopolysaccharide could be removed by gently washing in water for 1 min and 60% by brushing for 1 min with a slowly rotating brush. These studies suggested that an almost complete debridement of root surfaces might be achieved by relatively simple andatraumatic measures. Therefore, intentional excessive removal of cementum during root planning in order to eliminate endotoxins from the exposed root was not justified.

The efficacy of ultrasonic scaler on removal of endotoxin has been investigated. The cavitational activity is considered effective for removal of plaque and endotoxin. These studies suggested that ultrasonic scalers are effective for periodontal treatment, as they are capable of removing endotoxin located on the root surface without excessive removal of cementum or dentin.

ROOT SURFACE REMOVAL BY SCALING AND ROOT PLANING

Cementum removal during scaling and root planing with manual scalers was reported to be 57.8 lm with 40 strokes by Horning et al. and 60 lm with 20 strokes by Coldiron et al. Ishizuka and co-workers reported that the root surface removal by Gracey curette was 39 lm with 750 g lateral pressure per stroke, for the first 50 strokes. The amount of root substance removal increased with force. When using
fine curette, the loss of substance per working stroke with clinically applied forces was reported to be 9.1 lm. Zappa et al. also reported that significantly more root substance was removed when the force applied was strong. Ritz et al. found that the amount of root substance removed by an ultrasonic scaler, sonic scaler, diamond bur, and fine curette per stroke was 17.2 lm, 4.37.8 lm, 7.9 15.5 lm and 522 lm, respectively. While comparing manual and ultrasonic scalers, some reports indicated that the manual scaler removes more root substance, whereas others reported that ultrasonic scalers do so. According to these studies, the root substance removal with one stroke was 120 lm and it varied depending on the site of the tooth, the power of the power-driven scaler, the shape of the tip, and whether the root surface was exposed or not.

REQUIRED TIME AND CLINICAL OUTCOME FOR SCALING AND ROOT PLANING

Badersten et al. compared the clinical effects of subgingival debridement using manual and ultrasonic instruments, and reported no differences in terms of probing depth, clinical attachment level, and gingival recession after 2 years. However, they pointed out that manual instrumentation took longer to achieve the same clinical outcome.

Jotikasthira et al. scaled root surfaces with plaque and calculus using sonic or ultrasonic instruments or with a new reciprocating scaling insert for the EVA / PROFIN system in vitro. Although the reciprocating insert gave results similar to those of the ultrasonic scaler, the scaling time was significantly longer for the new cleansing principle.

Busslinger et al. compared the time needed, calculus removal, and root surface roughness after scaling with a magnetostrictive ultrasonic scaler, a piezoelectric ultrasonic scaler, and a hand curette in vitro. The time needed for instrumentation was 126.1 ± 38.2 s for the curette, which was longer than the piezoelectric ultrasonic scaler (74.1 ± 27.6 s; p < 0.05) and the magnetostrictive ultrasonic scaler (104.9 ± 25.4 s; p>0.05). The piezoelectric scaler was more efficient than the magnetostrictive scaler in removing calculus, but left the instrumented tooth surface rougher.

Matsuo et al. extracted 40 teeth after subgingival scaling and root planing using various manual instruments, and evaluated residual calculus and deposits. The amount of residual calculus and deposits was greatest on the molar teeth, followed by premolar and anterior teeth. Teeth with pockets less than 3 mm had the least amount of residual calculus and deposits, whereas teeth with pockets over 5 mm showed greater residual calculus and deposits than teeth with pockets less than 5 mm. They concluded that scaling and root planing with manual scaler was effective when the pocket depth was less than 5 mm. The conditions differed for single and multirooted teeth.

Izumi et al. compared the effects of scaling and root planing performed from approximately 1 mm coronal to the base of the pocket or from the base of the probable pocket to the gingival margin. For periodontal pockets deeper than 3.5 mm, the pocket reduction and attachment gain were greater when scaling and root planing was performed from the base of the pocket. They concluded that the trauma caused to the most coronal part of the connective tissue attachment by scaling and root planing seemed to be of minor importance compared to the effective removal of subgingival deposits.

ACCESS TO FURCATION AREAS

The access to furcations or deep pockets is influenced by the shape of the instrument and the shape of the pocket or root surface. Some reports showed that the skill of the operator was highly important. The comparative study of manual scaling vs. ultrasonic debridement by Leon & Vogel concluded that both instruments were equally effective in Class I furcations. However, ultrasonic debridement was significantly more effective than manual scaling in Class II and III furcations.

A newly designed tip, which resembles a furcation probe with a spherical end, was developed to improve access to the furcation area. Oda & Ishikawa introduced this new ultrasonic scaler insert specifically designed for furcation areas. This insert is shaped like a short section of a spiral with a curvature radius of about 9 mm. The tip is a sphere with a diameter of 0.8 mm. This insert seemed to have better access to furcation areas than a straight probe-like insert, and in vitro experiments have demonstrated that it is significantly more effective than Gracey curettes. Taskacs et al. compared the scaling efficacy of four types of modified tips of Cavitron (prototype Cavitron insert with a spherical tip of diameter 0.8 mm (Ball Point Tip), Cavitron insert (EWP-12 L: Pointed Tip), ENAC (furcation insert with a spherical tip of diameter 0.8 mm), and Titan sonic scaler (universal type insert: no. 56801) in the furcation area. They reported greater efficacy with the ball point inserts of Cavitron and ENAC or the universal type insert of Titan.

RECENT DEVELOPMENTS OF MANUAL AND POWER-DRIVEN SCALERS

In the past few years, researchers have tried to modify scaling instruments for use in various situations where operators experienced difficulties in performing mechanical debridement. These modifications were aimed to improve the efficacy, as well as ease of scaling and root planing. Recently, extended shank curettes for deep subgingival scaling or flap operation, and mini-bladed curettes for narrow pockets at the midlingual or midpalatal have become available. In another type, the diameter of the shank has been modified (Fig. 3). In addition, many other types of curettes have been developed. Two double-ended curettes for mesial and distal surfaces of the posterior teeth have been added to the set of Gracey curettes. A comparative study of a short-blade, long-shank curette newly developed for deep pockets at incisors, and a conventional Gracey 1/2 curette demonstrated that the new curettes were more effective for anterior narrow and deep pockets, although they made the root surface rougher.

Gantes et al. developed a plastic tip, made of a
strong plastic material, for use with a sonic scaler, and evaluated its efficacy in removing dentin substance in vitro and mature supragingival plaque in vivo. Instrumentation with the sonic scaler fitted with the plastic tip removed considerably less dentin and resulted in a smoother dentin surface than instrumentation with the curette, or the sonic scaler with an ordinary metal tip. The plastic tip efficiently removed mature plaque within 5 s. They concluded that the new plastic tip might be useful especially for maintenance therapy, with less risk for iatrogenic effects on root surfaces.

A new instrument designed for root debridement, Periosonic, which is a modified version of the endodontic system, has also been introduced. The instrument has two types of files inserted in a sonic handpiece. The Periosonic 1 file resembles a reamer with a 16-mm working tip, and is used to remove heavy supra- and subgingival calculus. The Periosonic 2 file is more flexible and less aggressive than Periosonic 1. Its one-sided working tip is 21 mm long. This file was designed for subgingival debridement, where the smooth part of the file faces the soft tissue wall in a periodontal pocket to minimize trauma.

Various modified power-driven scaler tips, such as tiny, thin, periodontal probe type, rounded top, diamond coated and contra-angled inserts for use in deep pockets have been developed. Dragoo et al. examined a manual scaler (universal curette) and ultrasonic scalers (Cavitron) with modified (contra-angled tips EW-P10R and EW-P10L which resemble a periodontal probein size and shape) and an unmodified (P-10 type) inserts in debridement of hopeless single or multirooted teeth. They evaluated the pocket depth, instrument limit, and instrument efficiency. The modified inserts showed added benefits. Yukna et al. developed a diamond-coated ultrasonic tip, the shape of which resembled a universal one (Cavitron) and evaluated its effectiveness in the removal of subgingival calculus on single-rooted teeth with probing depths of 512 mm in 15 patients. Results indicated that the diamond-coated ultrasonic tips were much more efficient than conventional or the universal tip in removing calculus. But these diamond-coated tips left the roughest root surface after instrumentation.

**SUMMARY AND CONCLUSION**

It is clear from the literature that scaling and root planing play a pivotal role in the elimination of causative factors of periodontal disease throughout periodontal therapy, including the nonsurgical, surgical and maintenance phases. In the past, it had been generally agreed that excessive root surface removal by hand instruments was necessary to remove the tenacious calculus deposits. However, research over the past years has shown that definitive root surface detoxification can be achieved without excessive cementum removal or aggressive instrumentation.

Complete cementum removal is no longer a requisite. Many studies have demonstrated that hand and power-driven instruments are equally effective in reducing the probing depth, attaining attachment level gains and reducing inflammation by removal of plaque bacteria, calculus, and endotoxin. Power-driven instruments have many advantages over the manual scalers; however, further studies are needed to improve the performance of currently available instruments. These include the development of a more effective tip and ultrasonic generator unit. Long-term randomized controlled studies are also required to examine the efficacy of the newly designed scalers. These studies would help to provide treatment based on exact information regarding the instrument and technology.

**REFERENCES**

13. Copulos TA, Low SB, Walker CB, Trebilcock YY, Hefti