CLINICAL APPLICATIONS
OF ULTRASONIC
INSTRUMENTATION IN THE
SURGICAL REMOVAL OF BONE

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Clinical applications of ultrasonic instrumentation in the surgical removal of bone

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The clinical use of ultrasonic inserts in the surgical removal of alveolar bone has been evaluated. Surgical applications included the removal of 19 teeth and the osseous management of periodontal disease in 50 cases. Histologic material was provided by resected bone fragments attached by periodontal tissues in anatomic rotation to removed teeth. Microscopic observations of sections revealed that planed surfaces of bone were smooth, while incised edges were irregular. Evidence for residual debris was absent. No alterations in adjacent lacunar osteocytes, vascular channels, and underlying periodontal tissues were noted. In clinical use, the ultrasonic inserts were found to remove bone with ease and preciosity. Hemorrhage from surgical sites was minimal or absent. Healing of tissues was uneventful with no postoperative complications encountered. Patients reported minimal discomfort during and following the surgical application of this instrumentation.

A variety of instruments are used in the surgical removal and recontouring of bone. These commonly include chisels, files, gouges, and rotating instruments, such as steel and carbide burs and diamond stones. Less attention, however, has been given to the use of ultrasonic instruments for the removal of mineralized tissues.

In early studies, ultrasonic tools were developed to cut dento-osseous structures.1 2 The effect of cutting was originally produced by vibrating a slurry of particles between the tip of the ultrasonic vibrating instrument and the tooth structure. The use of an abrasive slurry was believed to increase the speed of cutting. This methodology was adapted for industrial use where it was initially developed to cut hard substances.4 5 Richman appears to have been the first to report the surgical use of an ultrasonic bone chisel without slurry to remove bone and resorb roots in apicoectomies.6 Two later studies reported evidence for the use of an ultrasonic scalpel-like blade to directly cut osseous tissue.6 7 More recently, we also had reported that a chisel-shaped ultrasonic instrument is capable of cutting bone when used without a slurry mix.8

Our histologic comparisons of defects in dog alveolar bone revealed that healing proceeded at a more rapid rate when using either the ultrasonic instrument or a surgical chisel instead of a rotary bur.

We have now used, under differing clinical conditions, ultrasonic instrumentation in the surgical removal of osseous tissue. Reported herein are histologic and clinical observations using this technic in the surgical removal of teeth and in periodontal therapy involving osseous management.

MATERIALS AND METHODS

Equal numbers of consenting men and women participated in this study. All patients were essentially healthy except for teeth requiring extraction and/or periodontal disease. The procedure was fully explained to each subject, and consent was obtained prior to appointment.

Ultrasonic instruments used for the removal of bone were the standard P-3 and P-9 inserts powered from a
evidence for a direct step had rep. is capable of a slurry mix. dog alveolar bone more rapid removal or a clinical condition-surgical resection histologic specimen in the surgery involving.

women patient essentially normal and/or fully explained prior to ap- proval of bone removed from a conventional unit. Unit settings were adjusted to obtain optimum performance for each insert according to the manufacturer’s recommendation. A water spray emanating from each insert was in use during all pro- cedures.

Clinical evaluations and deno-osseous material for histologic examinations were provided by the removal of 19 teeth requiring surgical extraction from 16 pa- tients using a modification of the method of Ramfjord and Costich. Following buccal mucoperiosteal flap reflection, ultrasonic instruments were used to make mesial and distal linear incisions opposite tooth line angles in the exposed bone. Bone incisions extended apically up to 5 mm. from the alveolar crest and to the depth of the periodontium. Each incompletely separ- ated bone fragment was then grooved to demarcate the fragment into a coronal and apical half. On the apical half, the ultrasonic instrument was planed across the surface to partially remove the outer layer of bone. The surface of the coronal half remained as an untouched control. Complete separation of the bone fragment from the alveolus was then accomplished by a third incision joining prior mesial and distal incisions at their apical extent. The bone fragment, although now sepa- rated from alveolar bone, still remained attached by ligaments of the periodontium in anatomic relation to the tooth. The tooth was removed without displacement of the attached bone fragment and immediately placed in 10 percent buffered formalin. Reflected tissue was approximated with interrupted 4-0 silk sutures which were removed on the fourth postoperative day.

After removal of the tooth crowns, each specimen was decalcified in ethylenediaminetetraacetic acid. Gross bisections of 11 specimens were made along the apical axis. The other eight specimens were grossed in...
cross-section. All bisected fragments were embedded separately in paraffin. Sections 6 μm thick were cut from the middle of each bisected surface towards and beyond the osseous borders. Tissue sections were stained with hematoxylin and eosin, Masson trichrome, periodic acid-Schiff, and phosphotungstic acid hematoxylin and were then submitted for microscopic evaluation.

Clinical evaluations of the ultrasonic instrument in removing osseous tissue also were made in the treatment of 50 patients presenting with periodontal disease requiring osseous management. Following accepted procedures to reflect the mucogingival soft tissue, alveolar bone was exposed. As necessary, the ultrasonic instrument was used to perform ostectomies and osteoplasties. Reflected flaps were approximated with
continuous sling and/or interrupted 4-0 silk sutures and the placement of a periodontal dressing as needed. Sutures and periodontal dressings were routinely removed on the seventh postoperative day.

Postoperative medication for each patient following surgery consisted routinely of a prescription for Phenaphen,* one tablet every 4 hours as needed for pain. During the postoperative period, each patient was observed daily and evaluated for pain, swelling, fever, malaise, medication taken, and any untoward symptoms which could possibly be attributed to the use of the ultrasonic instrument.

RESULTS
Histologic observations.

The cut edge of the bone fragment was irregular with the use of the P-3 insert (Fig. 1). In addition, separations along lamellar planes of the bone from the cut surface also were noted. Evidence for residual debris within these areas was absent. Osteocytes were observed residing within lacunae in immediate proximity to the cut surface.

The demarcation groove made to separate the apical from the coronal half of the bone fragment was easily identified (Fig. 2). Bone on the apical surface, which was planed, did not appear burned nor compressed. It removed cleanly without surface disruptions.

The periodontal tissue underlying and adjacent to areas of removed bone was examined and found free of alterations (Fig. 3). Evidence for an effect of the ultrasonic instrument upon vascular channels was absent. Further, no disruption in the orientation of periodontal fiber bundles was observed. Examination of specimens by means of polarized light revealed no deviations in the collagenous components of the periodontal membrane.

In the clinical management of excising the bone fragments, the attempt was made to prevent the penetration of ultrasonic inserts through the periodontal membrane space to the tooth surface. In a few cases, however, histologic evidence revealed that the underlying root surface had been compromised with removal of both cementum and dentin (Fig. 4). Cut surfaces of these tissues appeared smooth and without separations along incremental or tubular lines, respectively. Evidence for mineralized residues removed from these teeth was not noted.

Clinical observations

Both inserts, the standard P-3 and P-9, were found to remove bone without difficulty. Precise linear cuts on the intact bone surface were initially accomplished with greater ease with the P-9 instrument than with the P-3. However, once the dense cortical plate of bone was disrupted, either insert removed the underlying osseous tissue with equal speed. Lack of such insert difference was particularly evident when inserts were applied to bony surfaces compromised by periodontal disease.

In all surgical procedures, hemorrhage was routinely minimal. The operative field remained free and clear of debris. Cavitation of the water spray produced at the vibrating tip kept the surface of boney tissue but did not interfere with visualizing the effect of the instrument in removing bone. Continued use of the instrument, therefore, could be accomplished without interruption.

Particles of removed bone were not apparent during the cutting procedures. The cut bone surface was smooth to the touch, except when a linear cut was made perpendicular to the surface. Such marginal root sharpness was easily removed by bevelling the teeth with the P-3 insert.
All patients were familiar with ultrasonic instruments before their surgical procedures through prior exposure with dental hygiene therapy, and none of the patients related negative feelings. Those few patients experiencing previous oral surgical procedures involving bone removal described this procedure as less physically traumatic than their experiences with chisel use and less anxiety-inducing than with the use of a rotary instrument. However, there was not sufficient sampling of these patients to evaluate statistical differences in their reactions to methods of bone removal.

Postoperatively, discomfort in patients was minimal. Their described use of prescribed medication never exceeded 24 hours. No evidence of any postoperative swelling was found in any of the patients, nor were any other complications noted.

DISCUSSION

This study was undertaken to evaluate the use of ultrasonic instrumentation in the surgical removal of bone under clinical conditions. Surgical procedures used were the removal of teeth and the osseous management of periodontal disease. Evaluations of instrument use were provided by histologic and clinical material.

Histologic studies using this instrumentation have been reported. Most recently, we performed a histologic comparison of the effect of a standard ultrasonic insert with a rotary bur and a surgical chisel. The ultrasonic insert, like the surgical chisel, was found to cut and not burnish bone. While the rotary bur was observed to produce the smoothest surface to removed bone, the rate of bone healing proceeded best when bone was removed by surgical chisel or ultrasonic insert.

Histologic observations on bone removed in this study support and extend prior findings. The edges of bone cut perpendicular to the surface were irregular. In contrast, when bone was removed by planing, the result was a smooth surface without irregularities. In addition, lacunar osteocytes immediately subjacent to all cut surfaces were visible, and no evidence for disruption of adjacent vascular channels was found. Such observations have been used as positive criteria by others in evaluating surgical methods in the removal of bone.

The use of ultrasonic instrumentation to surgically remove bone is further substantiated by our clinical observations. The instrument is operationally more capable of being placed with greater ease in all dentulous locations than the bulkier rotary handpieces. Additionally, operator-derived motion and force with hand chisels are obviated. Furthermore, the working area at the tip of the insert provides precise control to the amount of bone to be removed. This control is derived through the specific reciprocating motion of the insert tip. This motion is elliptical wherein forward movement by the tip through the major axis travels 0.003 inches at full power. Consequently, selection

*Personal communication: Cavition Ultrasoundics, Long Island, N.Y.
available inserts allows alveolar bone surfaces to be thinned, beveled, rounded, or totally removed.

Patient acceptance and clinical evaluations of healing following use of this instrument were positive. In all treatment procedures using ultrasonics, postoperative complications were lacking.

We were previously unaware of the initial description of the clinical removal of bone by an ultrasonic chisel reported by Richman.6 His chisel insert was used in a planing fashion to remove overlying alveolar bone and subjacent root apices in apicoectomy procedures. In over 32 clinical cases, he found healing uneventful without postoperative complications. Patient acceptance through reduced discomfort and operator acceptance were both noted. In addition, Richman applied ultrasonic instrumentation to all endodontic procedures including opening into, cleaning and enlarging, sterilizing and drying, and the filling of pulp canals in both anterior and posterior teeth. More recently, the comparative superiority of ultrasonic-powered, hand-held K type files has been reported for the in vitro removal of dentin.17

Two Russian investigators, Petrovskiy and Petrov,18 reported study and application of ultrasonic cutting of bone in thoracic surgery. The cutting edge of their insert possessed notches to produce a "sawing" effect. In the absence of any described coolant to dissipate heat, they conducted in vitro studies on temperature fields produced in bone during ultrasonic dissections. In the "porous mass" of bone, the temperature did not exceed 45°C on a plane 1 mm from the line of cutting and dropped to approximately 22°C 3 mm distant. Histologic examination of bone specimens derived from their ultrasonic dissections of sternum revealed that "the zones of specific change did not exceed 0.025 mm." Their clinical experiences gained in 107 thoracic operations indicated that hemostasis was so sufficiently minimal that no controls for hemostasis were required. Finally, postoperative complications in their patients were reportedly absent and all experienced "much less postoperative pain than usual." In thoracic surgery, they reported ultrasonic dissection to be advantageous in "sternotomy, resection of ribs, cutting of syndromes, removal of rib regenerates during dermoplasties, and bone resection in inaccessible places, e.g., in removing the first rib during an upper thoracoplasty."18

Our observations on the surgical application of ultrasonic inserts are consistent with those reported by others.3, 7-11 In those instruments are capable of removing mineralized tissue with ease and efficiency. Histologic changes characterized as deimittal in bone following surgery have not been found evident following ultrasonic use.7-11 In clinical practice, healing following oral and thoracic surgery has proceeded uneventful and without complications.3-11 In addition, patient discomfort appears reduced, resulting in a high degree of acceptance. Finally, when used to remove bone, the design of the insert may be critical wherein sharp or blunt chisel-shapes with or without serrations may be more favorable than scalpel-like blades.3-6, 8, 12, 13

SUMMARY

Ultrasonic instrumentation has been clinically used in the surgical removal of teeth and periodontal therapy requiring osseous management. Histologic observations of resected bone fragments indicated lacunar osteocytes residing immediately adjacent to cut surfaces. Evidence for disruption in orientation of subjacent periodontal fiber bundles, or of adjacent vascular channels, was lacking. Cut edges of incised bone appeared irregular, while surfaces of planed bone appeared smooth. Clinical evaluations of the use of ultrasonic inserts to remove mineralized tissue were positive. Supportive criteria included ease of instrument application and use at surgical sites, preciseness of bony removal, hemorrage control, uneventful healing with lack of postoperative sequelae, and patient acceptance with minimal discomfort. The use of ultrasonic instrumentation in the surgical removal of mineralized tissue may prove a promising addition to the clinician’s armamentarium.

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