Ultrasonic Instrumentation Instruction in Dental Hygiene Programs in the United States

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Abstract

Purpose: The purpose of this study was to determine the extent of ultrasonic scaling instrumentation instruction in dental hygiene programs in the U.S. Currently, there is no publication available defining a consensus of instruction for ultrasonic instrumentation.

Methods: Exempt status was received from the West Virginia University Institutional Review Board. A survey was developed with dental hygiene administrators and faculty, based on assumptions and a list of questions to be answered. The survey was tested for validity and revised after feedback from additional faculty. The instrument was 64 questions divided into demographics, curriculum and equipment. Most questions included a text box for additional comments. An email survey was sent to all directors of accredited dental hygiene programs in the U.S. (n=323). The final possible number of respondents was n=301. Results were collected in aggregate through the Secure Online Environment (SOLE). Results were transferred to an Excel spreadsheet for statistical analysis.

Results: After 3 emails, the response rate was 45% (n=136). No significant differences in methods of instruction were found between associate and baccalaureate degree granting programs. Eighty-nine percent of programs introduce hand scaling prior to ultrasonic scaling instruction. Students in 96% of the programs were required to administer pre-procedural mouth rinse intended to reduce the amount of bacteria. The magnetostrictive ultrasonic scaler is widely used in dental hygiene instruction. A variety of inserts/ tips were available although a universal or straight insert/tip was most common. Calculus, not inflammation, was the primary criterion for ultrasonic scaler use.

Conclusion: The results of this study demonstrate that ultrasonic instrumentation is an integral component of the clinical curriculum and the majority of the dental hygiene programs prescribe to similar teaching methods. Programs could benefit from incorporating current scientific research findings of using site specific inserts to perform periodontal debridement based on thorough biofilm removal measured by resolution of inflammation.

Keywords: acoustic turbulence, cavitation, lavage, debridement

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Introduction

Ongoing research of periodontal disease has provided the professional community with a comprehensive foundation of information, leading to significant improvements in effective treatment options. Management of periodontal disease includes understanding the association between systemic health and oral health along with understanding available therapeutic treatment. Historically, periodontal scaling and root planing were accomplished using hand instruments because ultrasonic scalers were originally designed for gross scaling and removal of supragingival calculus.[1-4] Originally, the tips of ultrasonic scalers were too large to fit into the sulcus around the tooth.[1-4] Now there is a body of evidence that supports the efficacy of modern ultrasonic instrumentation with longer and thinner tips, offering a valuable component of periodontal therapy.[3-5]

Based on the Commission on Dental Accreditation (CODA) Dental Hygiene Standards, dental hygiene programs would be expected to teach content on the theory for periodontal therapy that is current and evidence-based which would include ultrasonic instrumentation. Instruction would include the therapeutic mechanism of the ultrasonic action, ultrasonic instrumentation technique including the adaptation of various inserts in relation to tooth morphology, the rationale and criteria for use of inserts, infection control, and the application of these principles through actual clinical experience. Development of a clinical competency measure of student proficiency using an ultrasonic scaler throughout the clinical experience would be expected.[6] The information provided by this study could assist in reevaluating portions of ultrasonic curriculum while validating other segments

of instruction, thereby establishing consistency of theory and practice.

The past 50 years saw a change in the methods, rationale and theory for periodontal debridement. In the 1960s and 1970s, practitioners advocated aggressive hand scaling and root planing with the purpose of achieving a glassy smooth finish which resulted in removing pathogens along with excessive amounts of tooth structure, often resulting in dentinal hypersensitivity.[3-5,7,8] Gracey curets designed in the 1970s were effective in achieving the glassy smooth root surface that was thought to inhibit new calculus accumulation.[2,5] Ultrasonic scaling was viewed as an adjunct used prior to fine hand scaling.[3] The role of bacteria was still unclear during this period.[2]

Study results revealed a paradigm shift in the mid-1980s and 1990s. Dental biofilm and free-flowing planktonic bacteria were established as the cause of periodontal infection; the infection could be treated effectively with the ultrasonic unit set on low power to remove bacteria and calculus.[2,4] Calculus was recognized as a niche for bacterial growth and a retainer of bacterial toxins and other byproducts.[2,4,9-16] Tooth structure was preserved while calculus was burnished due to the low power setting and pathogens remained. The result was soft tissue ulcerations over burnished calculus deposits resulting in chronic inflammation.[2]

In March 1990, Smart et al published the results of an in vitro study of conservative therapy with ultrasonic scaling of the root surface alone. The study found that the ability of the ultrasonic scaler to detoxify root surfaces was significant. This finding suggested that conventional root planing was unnecessary.[8]

In 1993, the term "debridement" was introduced to dental hygiene students by Irene Woodall. Debridement advocated the treatment of the root surface, the pocket space and the pocket wall to promote healing.[5,8,9,11,17-20] This recognized and addressed the need for elimination of pathogens and tissue response instead of only calculus removal for the treatment of periodontal inflammation. In contrast, the focus of root planing was on deposit removal and a glassy smooth root surface, not the reduction of pathogens.

Today, ultrasonic scaling is recommended for the treatment of periodontal disease using a variety of inserts designed for reaching deeper into the sulcus and to adapt to root concavities. The suggested process starts with the ultrasonic scaler used on medium to high power to remove the bulk of calculus, then progressing to a medium-low power setting using a thin tip insert and removing the residual deposits, biofilm and endotoxins. Ultrasonic inserts were redesigned with smaller tip diameters and longer shanks to access deep subgingival pockets for disruption of the biofilm, which is necessary for control of periodontal disease. Micro-ultrasonic thin tip inserts were shown to be superior to manual instrumentation when accessing deep, narrow defects and class II and III furcations.[10,16,18,21] Numerous studies were performed comparing ultrasonic scaling and hand scaling with varying results. At minimum, the two were equal in effectiveness with respect to probing depth reduction, gain of clinical attachment and decreased clinical inflammation.[3,5,9-10,21-29] Periodontal debridement continues to be the gold standard for periodontal disease treatment.[15,17] In addition, ultrasonic scalers may require less time to complete subgingival debridement with decreased clinician fatigue.[3,5,9,21,22] Alterations of the tooth surface are directly related to the amount of pressure applied by an instrument - less pressure, less cementum removed.[4,5,7] Ultrasonic scaling required less pressure to accomplish removal of calculus, endotoxins and biofilm without removal of cementum.[8,9] The 1990s produced research which recognized that cementum removal was not necessary for treatment of periodontal disease.[8,9]

Ultrasonic scalers provide a mechanical disruption of the plaque biofilm by the movement of the insert tip and the subsequent lavage flushed debris from the sulcus. Cavitation produced by the ultrasonic vibration of the tips helps to break up the subgingival bacterial plaque.[3,5,9,11,12] The areas reached by the cavitation are detoxified which reduces the periodontal-disease-causing pathogen load.[10,13,14]

More than 50 ultrasonic inserts have been designed to work in specific areas, for specific needs. A heavy tip would provide enough vibration on medium-high to high power to fracture heavy supra gingival calculus. A standard diameter tip insert would be used for general debridement or moderate to heavy supragingival and subgingival calculus. Slim diameter inserts were introduced in the late 1980s. An insert designed for subgingival periodontal debridement has a tip that is 40 to 47% thinner than the standard diameter tip with a longer shank that can reach 1 mm deeper than hand instruments, into subgingival areas, furcations, root concavities and interproximal areas.[2,5,18] As the insert tip diameter becomes smaller, less power is required to accomplish debridement.[5] The thin tip inserts should be used only on low to medium power. If not used properly, an ultrasonic insert tip used on low power can burnish rather than remove the calculus.[2,7,24,29] One study found more cavitation occurred with broader tips at the same power setting than the slimmer insert tips.[3,18]

Specialized insert tips are available. A beavertail tip has a wide working end, ideal for removing

thick tobacco stains, orthodontic cement and tenacious calculus. Site-specific inserts can have a right or left curved shank or a shank with a number of backbends, all designed to enhance adaptability to the root anatomy of the teeth.

Tips wear as a result of use, resulting in loss of effectiveness. One millimeter of tip wear will result in approximately 25% loss of efficiency.[4,5] Two millimeters of wear will result in approximately 50% loss of efficiency, and replacement would be required.[4,5] Wear guides can be obtained from the manufacturer.

Ultrasonic scaling instruments can be very effective with deliberate, multidirectional strokes, keeping the tip constantly moving. The entire surface of the tooth or root must be contacted by the side of the tip using short and overlapping vertical, horizontal and oblique strokes, in a cross-hatching pattern and working circumferentially for effective removal of biofilm pathogens.[2,4,5,8,30-32] Fracturing of calculus can be accomplished by working from the coronal or lateral boundary of the deposit, gently tapping the deposit using the active sides of the insert tip, unlike curets, which require the clinician to place the instrument under the apical aspect of the deposit. Increased pressure decreases the effectiveness of the tip by restricting or stopping the movement of the insert tip.[4,5,9]

Investigators have reported that ultrasonic scalers release bacteria-laden aerosol into the environment creating a biohazard.[3-5,7,16,32-37] Microorganisms can remain suspended for at least 30 minutes and up to 24 hours.[4,7,33] The area of exposure can be up to 20 feet from the treatment center. Having the patient rinse with an antimicrobial mouth rinse prior to treatment decreased the amount of bacteria in the mouth to be released into the air.[4,32-36,38] High-speed evacuation captured the excess water which significantly decreased the amount of bacteria-laden aerosol released into the air.[32-37] Studies showed that blood is present in the aerosols produced by ultrasonic scalers even though it is not visible.[10,35-37] The standard salvia ejector cannot capture aerosols adequately.[10,37] Adaptors added to the high-speed evacuation are available and would make it easier for the clinician to use the high-speed evacuation without assistance.[32,33] Proper cleaning of the operatory surfaces would be necessary due to the contamination by the aerosols produced by ultrasonic scalers.

Historically, cardiac pacemakers were considered a contraindication for the use of ultrasonic scalers. Pacemakers are shielded; therefore, the magnetostrictive ultrasonic electromagnetic field will pose no risk to a patient with a modern cardiac pacemaker.[39-41] The piezoelectric ultrasonic scaler did not produce an electromagnetic field.

The purpose of this study was to assess the level of ultrasonic instrumentation instruction employed in dental hygiene educational programs in the U.S. Currently, there is no publication available defining the current consensus of teaching methods for ultrasonic instrumentation in dental hygiene programs in the U.S.

Methods and Materials

Exempt status was received from the West Virginia University Institutional Review Board. A survey was developed with dental hygiene administrators and faculty of West Virginia University. The survey was tested for validity, using additional faculty to review the survey and revised after feedback. The instrument consisted of 64 questions asking about demographics, curriculum and equipment. Most questions included a text box for additional comments. An email survey was sent to all directors of accredited dental hygiene programs in the U.S. (n=323). The West Virginia University Secure Online Environment (SOLE) system was utilized for the email survey. A total of 3 emails were sent. Email addresses were obtained from The American Dental Education Association Directory of Institutional Members.

Results

Most questions allowed for more than one answer to be selected, therefore totals did not equal 100% for every question. After the first email, 22 subjects were eliminated for various reasons, including 3 programs without onsite student clinics, 2 program directors who stated they did not answer surveys, 1 director who responded that the program was too new, no email could be found for 1 program, 11 emails bounced back, and 4 automatic responses stated out of the office until fall (n=301). After 3 emails, the response rate was 45% (n=136). Results were collected in aggregate through SOLE and transferred to an Excel spreadsheet for statistical analysis.

Demographically, the programs were divided into 4 regions: Northeast, South, Midwest and West, using a regional designation employed by the U.S. Census. The response rate was the least from the northeast states (8.1%) and the greatest response rate was from the Midwest states (38.2%). There was no significant difference in the response rate between programs conferring associate degrees or bachelor degrees.

Pre-clinical instrumentation was introduced by 86% of the dental hygiene programs in the first term, with 26% including ultrasonic scaling instruction during the pre-clinical instrumentation course. No difference was noted between programs con-

ferring an associate degree and programs conferring a bachelors degree. The majority of programs (89.2%) introduced hand scaling instrumentation instruction prior to the introduction of ultrasonic scaling instrumentation instruction (Figure 1). Sixty nine percent of respondents reported that equal emphasis was placed on hand scaling instrumentation and ultrasonic scaling instrumentation (Figure 2).

Use of teaching strategies was explored (Figure 3). The most common strategy for teaching was the use of typodonts. Other teaching strategies included student partners (89%) and onsite clinical patients (83%).

Ultrasonic insert tip adaptation techniques taught in the program were also assessed. Five choices were provided (oblique, modified oblique, vertical, furcation adaptation and other). The 2 most common techniques were the oblique using the lateral insert surface (91%) and vertical strokes working parallel to the tooth similar to a probe (91%). Also taught was the modified oblique using the face and back of the insert (84%), followed by furcation adaptation (41%).

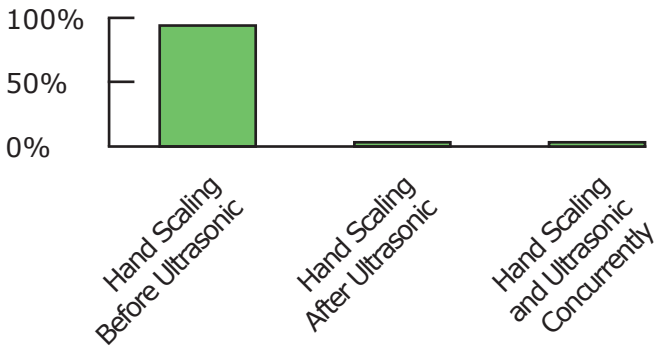
When asked about criterion for use of the ultrasonic scaler, 77% used the amount of calculus as a criterion. Stain was a criterion by 50% and degree of inflammation was reported by 31%.

The study asked about the prevalence of the 2 most common types of ultrasonic scalers. Magnetostrictive ultrasonic scalers were much more prevalent than piezoelectric ultrasonic scalers in dental hygiene programs and were reported to be used in 93% of the dental hygiene programs who responded. The majority of programs (80%) indicated that the ratio of magnetostrictive ultrasonic units to students was predominantly 1:1. Six programs (5%) required students to purchase their own magnetostrictive ultrasonic scaler unit.

Most programs (72%) required students to purchase ultrasonic scaler inserts while enrolled in the dental hygiene program. Figure 4 notes the magnetostrictive inserts students were required to purchase and which inserts were provided by the program. The slim diameter straight tip was the most common choice of tip.

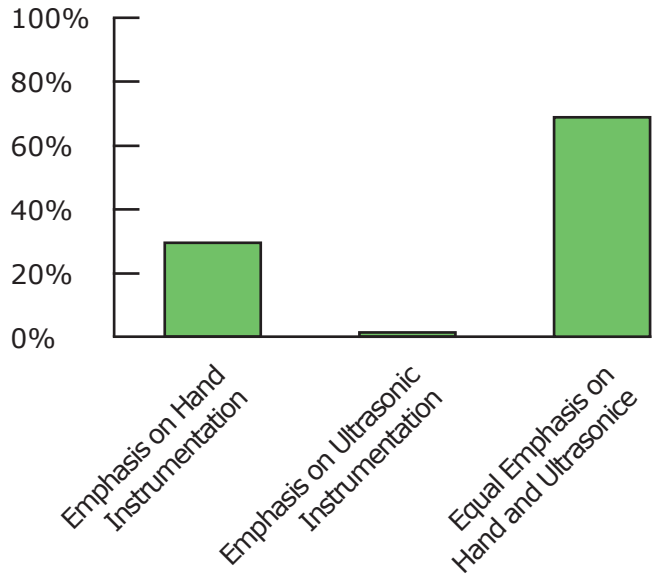
Sixty nine percent of programs (n=94) reported having piezoelectric ultrasonic scalers. Only 10 programs had a higher than a 1:5 ratio of piezoelectric ultrasonic scalers to students. Most reported using them for demonstration purposes. Most programs (69%) utilizing piezoelectric ultrasonic scalers provided the tips for students to use. The diamond coated tip was used with supervision (Figure 5).

Figure 1: Hand Scaling Instrumentation Instruction Relative to Ultrasonic Instrumentation Instruction (n=129)



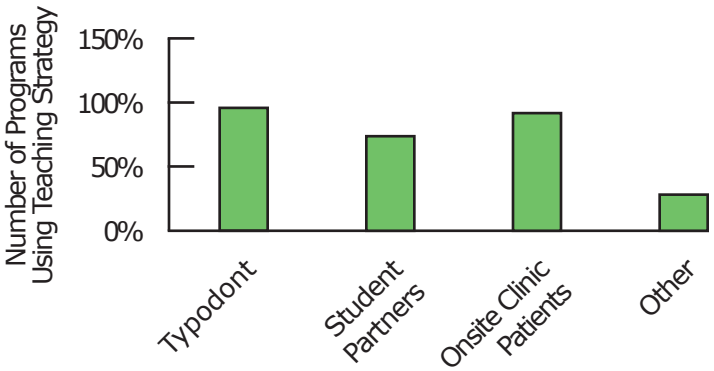
Hand Scaling Instruction Relative to Ultrasonic Scaling Instruction

Figure 2: Program Emphasis (n=131)



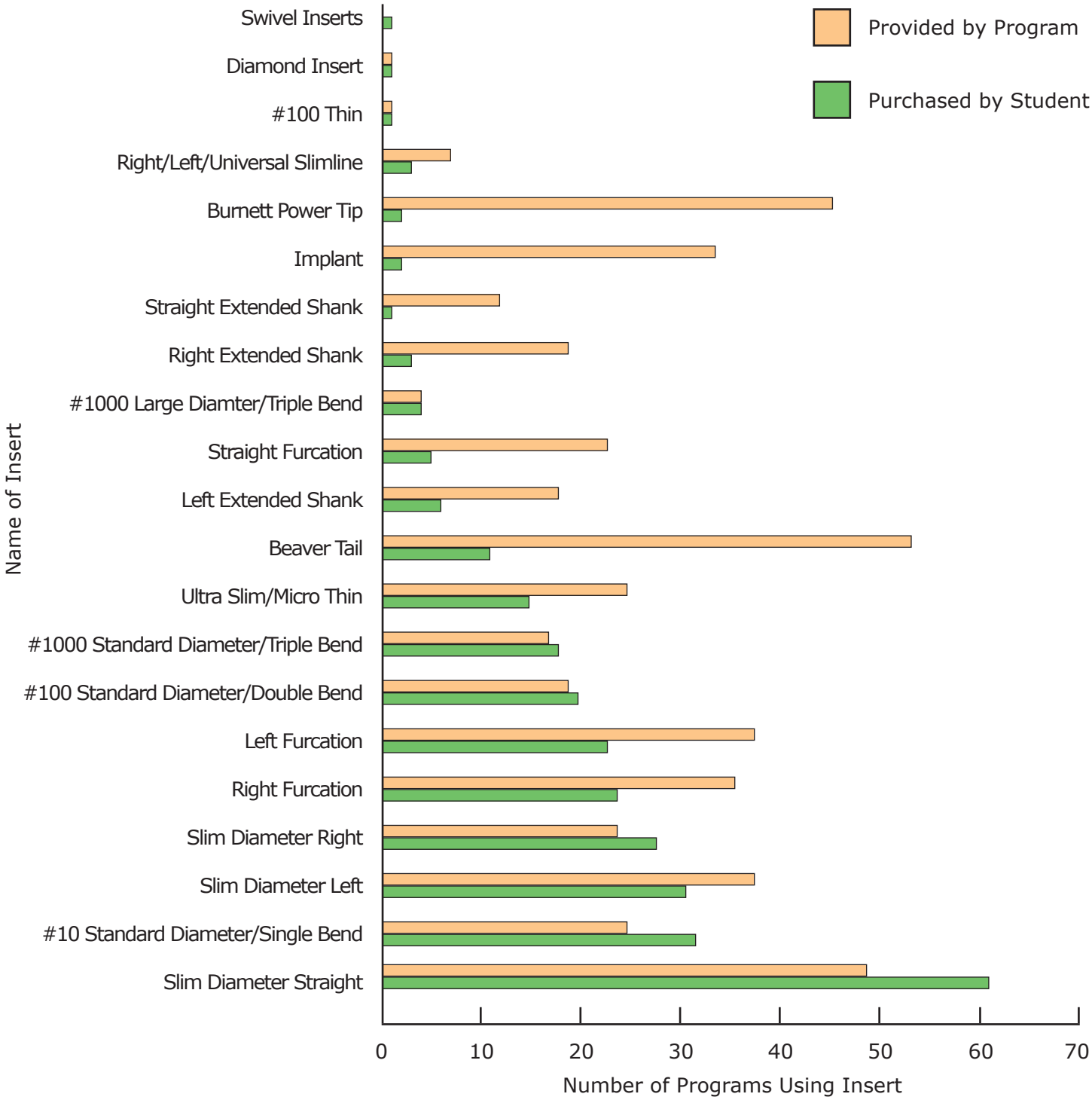
Emphasis

Figure 3: Teaching Strategies Used for Ultrasonic Instrumentation (n=131)



Strategies Used for Teaching Ultrasonic Instrumentation

Figure 4: Magnetostrictive Inserts Used by Programs

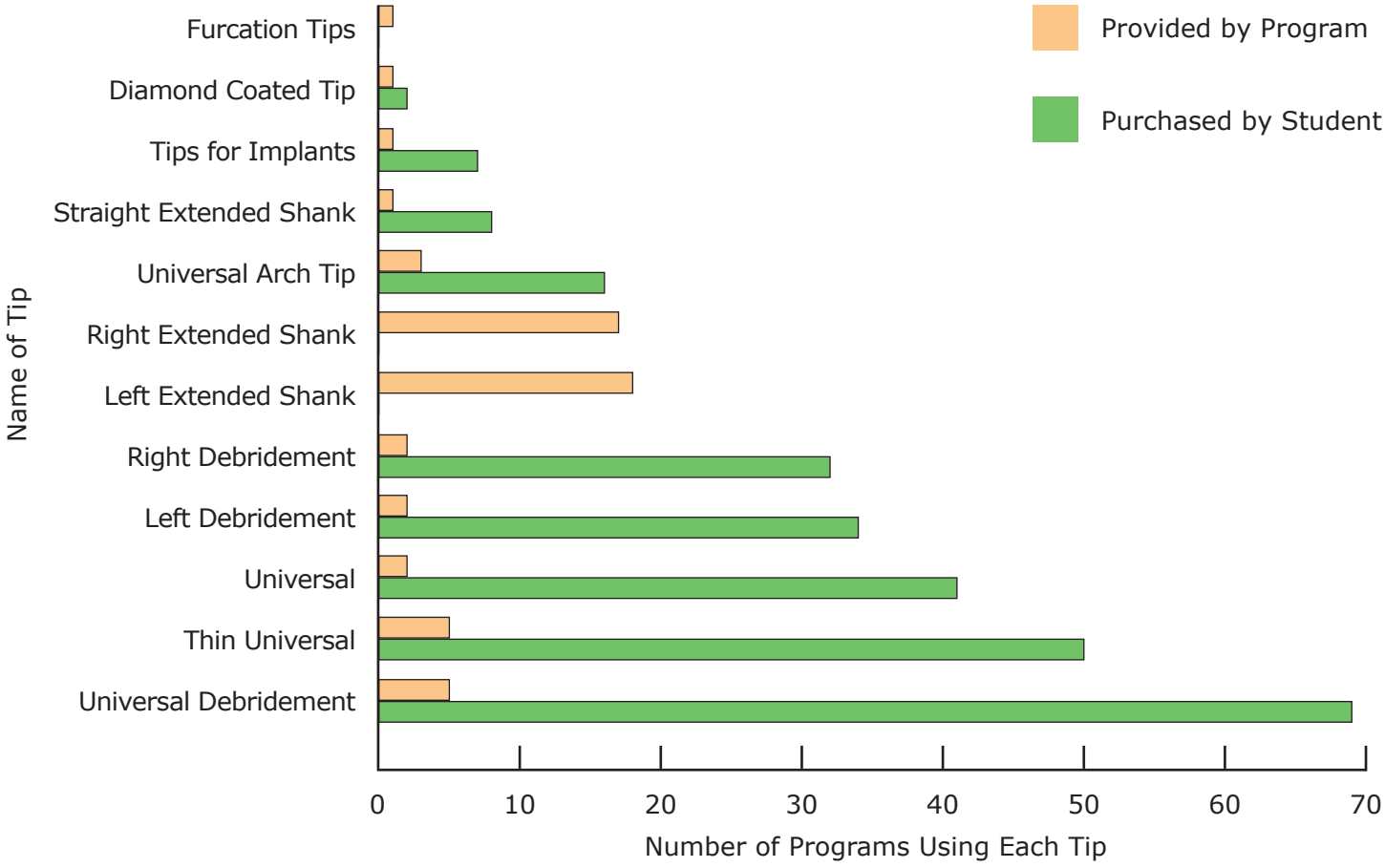


The majority (90%) incorporated more than one type of competency assessment for ultrasonic instrumentation (Figure 6). Methods included direct observation, pre- and post-exam by instructor and process examination by instructor. Six programs (5%) used additional methods including critical thinking narratives that included determination of instrument selection, techniques used and identification of correct treatment modalities for specific patients. Skill evaluation, self-evaluation and a written exam were utilized for competency assessment.

Discussion

The results of the study indicate that a majority of schools surveyed approach ultrasonic instrumentation instruction in a similar way. Most use the same textbooks and the same teaching methods, such as requiring a pre-procedural rinse, use high volume evacuation, teach ultrasonic instrumentation theory across the curriculum and encourage the students to use the ultrasonic scaler freely on all patient types. No significant differences were found between associate and baccalaureate degree granting programs.

Figure 5: Piezoelectric Tips

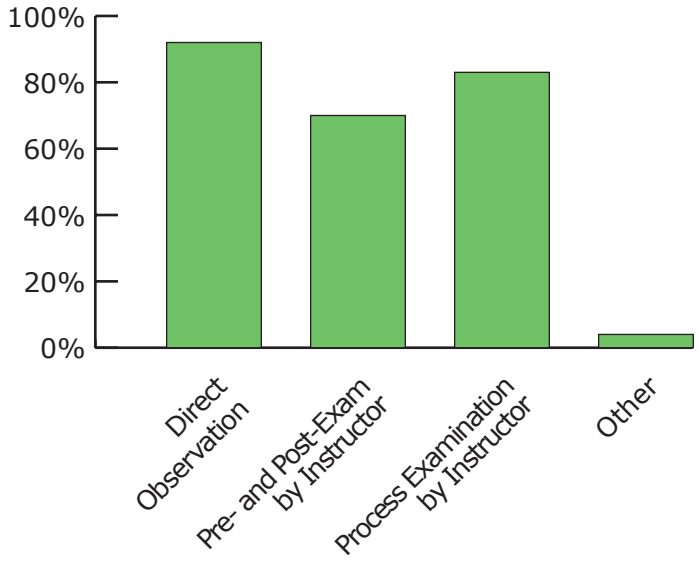


No research is available that addresses the consensus or extent of instruction of ultrasonic instrumentation in dental hygiene programs. Studies focus on the therapeutic effect of ultrasonic instrumentation versus hand instrumentation for the treatment of periodontal disease.[3,5,7,9,10,15-18,23,24,27-31]

The magnetostrictive ultrasonic scaler is taught in 93% of programs. The piezoelectric is primarily used as enrichment. Most respondents (68.7%) indicated that equal emphasis is placed on ultrasonic scaling; however, the majority of programs (89.2%) present hand scaling instruction prior to ultrasonic scaling instruction. There are a variety of inserts available but the most common is a slim diameter straight tip insert. Scientific literature demonstrates that utilization of site specific inserts maximizes efficacy and efficiency of deposit removal, minimizes root surface damage, minimizing the chance of burnishing calculus.[3,5,7,10,13,16,18,21,31]

Most programs (97.82%) cite calculus as a criterion for using the ultrasonic scaler, with 31% indicating inflammation as a criterion for ultrasonic debridement. This suggests that dental hygiene programs are still teaching a traditional approach to instrumentation. However, respondents agree that most patients benefit from the use of the ultrasonic scaler. Programs should reevaluate the criteria used

Figure 6: Evaluation Methods to Determine Competency (n=132)



to determine the need for ultrasonic instrumentation utilizing evidence-based and current philosophies of periodontal therapy that recognizes the key role of inflammation. Considering the vast amount of evidence implicating biofilm as the etiological

factor for periodontal disease rather than calculus, the current survey revealed that a traditional teaching approach is utilized by most dental hygiene programs.[2,5,9,11,14,15,17] Traditionally, instrumentation has been approached based on the presence of clinically-detectable calculus deposits, with the end point of therapy measured by the absence of clinically-detectable deposits. An approach that aligns with the current treatment philosophy of periodontal debridement would be based on thorough removal of biofilm in addition to calculus, with the end point of therapy measured by resolution or absence of inflammation.[2,5,9,11,14,15,17] The findings of this study indicate a disconnect between what is written in scientific literature and what is actually practiced in dental hygiene programs.

Conclusion

Dental hygiene programs in the U.S. universally embrace teaching ultrasonic instrumentation, and encourage ultrasonic use on all patient profiles. The majority of programs recognize the need for a pre-procedural mouth rinse, and the use of high volume evacuation to reduce the bacteria laden aerosol produced. Almost all programs cited calculus removal as the criterion for using the ultrasonic scaler. The results of this survey suggests that the teaching of instrumentation is not fully aligned with current treatment philosophy of periodontal debridement based on the need for thorough removal of biofilm using site specific inserts, with the end point of therapy measured by resolution or absence of inflammation.

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