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Dental hygienists' perception of preparation and use for ultrasonic instrumentation

Abstract: Objectives: Ultrasonic scaling technology has evolved dramatically providing greater clinical utility subgingivally including instrumentation of light deposits and biofilm disruption. It is unknown whether dental hygiene curriculum has kept pace with the progression and reflects current applications. The first part of this two-part study aimed to determine new dental hygiene graduates' use and perceptions of preparedness in ultrasonic instrumentation. Part 2 investigates ultrasonic curriculum from the programme director perspective and will be reported on in a subsequent paper. Method: Part 1 of the study surveys recently graduated Canadian dental hygienists about their use and perceptions of preparedness with ultrasonic instruments through an electronic guestionnaire developed for this study. Results: Participants reported using ultrasonics about half of their instrumentation time predominantly with magnetostrictive technology. Use focussed on heavier deposits with straight, slim inserts. Subjects were generally satisfied with ultrasonic education and felt reasonably well prepared in using ultrasonics. Higher levels of perceived preparedness were most associated with graduates from the 3-year diploma programme, whereas graduates from 18-month programmes were associated with greater levels of confidence in using ultrasonics. Confidence with ultrasonics did not have an effect on subsequent use - mostly all participants increased use once in practice. An earlier introduction and more practice time in school were both associated with increased feelings of preparation and confidence. Conclusions: New dental hygiene graduates perceive greater preparedness, confidence and use of ultrasonic instrumentation within a more traditional paradigm. In addition, the results indicate a potential incorrect and/or inappropriate application of current technology.

Key words: curriculum; dental hygiene; dental prophylaxis; dental scaling; periodontal pocket debridement; ultrasonics

Introduction

Over the last 60 years, ultrasonic equipment and its use in the dental field have evolved tremendously. In dentistry, ultrasonic technology was first used to power a tool designed for cavity preparation (1). While the air-driven handpiece became the instrument of choice for preparing teeth for restorations, in the 1950s, ultrasonic technology resulted in the development of the 'Cavitron', the key armamentarium for gross removal of heavy supragingival calculus in the treatment and prevention of periodontal disease (2, 3).

An exploration of the ultrasonic instrumentation research unveils a succession of studies describing the development of ultrasonic technology from its original 'traditional' design using thick inserts for primarily supragingival calculus removal, through to its more recent 'contemporary' application with thin inserts for removal of subgingival deposits including biofilm disruption. Through the 1960s and 1970s, scientists investigated the value of traditional ultrasonic inserts as stand-alone instruments for complete scaling procedures, including subgingival debridement, rather than merely a precursor to hand instrumentation (4-6). Study results demonstrated equal effectiveness in calculus removal by both hand and ultrasonic instrumentation. However, the traditional ultrasonic inserts were found to leave a rougher surface than did hand instruments (7, 8). In addition, it was unknown whether ultrasonic instrumentation removed diseased cementum, and therefore, there remained a perceived need to complete root planing with hand instruments (9).

In the early 1990s, Holbrook and Low (10) examined the benefits of newer contemporary inserts, which included modified, thinner, straight and curved inserts designed to more effectively negotiate deep, subgingival pockets. Soon after, Dragoo further explored this concept and, using only the left and right curved designs under medium power, showed these ultrasonic inserts had better access to deep periodontal pockets (11). This resulted in superior calculus and plaque removal and produced the least amount of root surface damage when compared to hand instruments and also to traditional, unmodified ultrasonic inserts (11).

Drisko's benchmark review article on ultrasonic technology for non-surgical periodontal therapy further confirmed these findings (12). This newly advocated contemporary approach to ultrasonics employed a substantial increase in the use of modified ultrasonic instruments for removal of lighter calculus and plaque biofilm in both supragingival and subgingival environments potentially reducing the need for surgical access or follow-up hand instrumentation (12). The development of these modified tips, which allow for greater depth of access and adaptation to curved root surfaces, advanced ultrasonic technology to meet, and potentially exceed, outcomes produced by hand instruments. A shift towards ultrasonic instrumentation as a 'first choice' in periodontal instrumentation became apparent in subsequent literature for dental hygienists and periodontists because of its perceived advantages (13–18) (Table 1).

While there has been an important evolution in ultrasonic technology, it is unknown whether this more contemporary approach to ultrasonic instrumentation is firmly established in the educational setting. Literature describing or quantifying the preparedness of the new dental hygiene clinician in the area of ultrasonic instrumentation, to the knowledge of these authors, has not been previously investigated in a comprehensive manner. One small-scale study conducted with novice dental hygienists revealed that six of the seven participants felt intimidated by ultrasonic instrumentation, and its use was usually reserved for clients with heavy, subgingival deposit (19).

The purpose of this study was to investigate dental hygiene graduates' perception of their preparedness and subsequent use of ultrasonic instrumentation following recent graduation from Canadian dental hygiene programmes. The aim is that the findings will inform future curriculum changes in dental hygiene education programmes to reflect a contemporary approach to ultrasonic instrumentation in preparing dental hygiene students to deliver evidence-based periodontal therapies. This study was supported by an unrestricted educational grant provided by DENTSPLY International, Dentsply Canada Division. The study coordinator is an educational specialist employed by the granting agency.

Methods

This study was conducted as a two-part survey with two distinct study populations and two respective survey instruments. The 'new graduate survey', part A, was conducted with practicing Canadian dental hygienists with 24 months or less practice experience. The 'faculty survey', part B, was conducted with Canadian dental hygiene programme directors. The study received ethical approval from the University of Manitoba Health Research Ethics Board (HREB). Both survey instruments were comprised primarily of closed-ended questionnaire items developed specifically for this study. SurveyMonkey[®] was used for the development and implementation of both of the electronic questionnaires. Prior to survey distribution, the questionnaires were pilot-tested with small convenience

	Table 1.	Comparison (of traditional a	and contemporary	v ultrasonic inserts	and approaches
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Traditional	Contemporary
Thick diameter inserts	Thin or ultra-thin diameter inserts; straight and curved designs
Subgingival access limited	Subgingival access is superior
Moderate to heavy calculus removal	Light calculus removal with focus on biofilm/plaque removal
Instrument contacts calculus	Instrument contacts calculus and/or cementum/dentin
Medium to high power settings typical	Low power setting typical; medium power may be an option
Basic level of knowledge/skill and short 'time on task' to achieve competence	Higher level of knowledge/skill and a longer 'time on task' to achieve competence
Complete debridement requires use of hand instruments Client/patient comfort challenging	Complete debridement possible with ultrasonics Client/patient comfort most usual

samples for testing content, comprehension and timing, and necessary modifications were made.

New graduate survey instrument - part A

The new graduate survey instrument (part A) included three sections: demographic background, use of ultrasonic instrumentation and perception of preparedness of ultrasonic instrumentation. Questionnaire items were mostly comprised of Likert scales (i.e. strongly agree [1] to strongly disagree [4]) allowing for descriptive and inferential statistics to be calculated.

For this part of the study, a census of dental hygienists graduating within 2 years of the survey date was selected from a membership list provided by the Canadian Dental Hygienists' Association (CDHA) of all 'active-practicing' Canadian dental hygienists. Newly graduated dental hygienists were targeted to participate in the study because of their recent educational exposure and anticipated ability to recall educational experiences. The survey was disseminated in English only to potential participants via email by the CDHA. Submitting a completed survey indicated participant consent. Potential study participants were under no obligation to participate in the survey, which was indicated in the consent disclosure statement preceding the survey items. The survey was open for 3 weeks, and two electronic reminders were given to increase response rate. Participants who completed the survey by the deadline were given the option of being entered in a draw to receive one of five \$100 gift cards as a token of appreciation.

Faculty survey instrument - part B

Part B of the study was conducted simultaneously with part A and included all dental hygiene programme directors/coordinators from across Canada to comprehensively gather information about ultrasonic curricula. Programme directors were permitted to complete the survey questionnaire with the assistance of faculty and staff. The survey was disseminated in English only by the study coordinator, and submission of a completed survey indicated consent to participate. Up to two electronic reminders were given to non-responders prior to the closing of the survey. Participating schools were entered in a draw for one gift (ultrasonic instruments) for their clinic with a value of approximately \$750.00 as a token of appreciation.

Data collection section – part A

Completed new graduate surveys were collected through the SurveyMonkey[®] program. The collected data from the survey instrument included no identifying information and were downloaded into an electronic spreadsheet (Microsoft Excel[®] 2010 for Microsoft Windows; Microsoft, Redmond, WA) accessible only to the research team. Participants' email addresses were stored separately, and at no time were individual responses linked to study subjects. The granting agency was not given

access to the raw data but will have access at their request to a final report with aggregated results for their information.

Anonymized data underwent quantitative analysis using SAS/STAT[®] by the Principal Investigator (PI) and statistician. Descriptive and inferential statistical calculations included frequencies, proportions, means and cross-tabulations to examine relationships between various curricular characteristics and the use and perceived perception of preparedness of ultrasonic instrumentation. Data are securely stored for a prescribed period of time and destroyed as per University of Manitoba requirements.

This study will report the results of part A only. The faculty survey, part B, will be reported on in a subsequent publication.

Results

Of the 1895 invited participants, 485 agreed to participate in the study, reflecting a 26% response rate. However, of these respondents, 64 individuals were excluded from the study because they had either not graduated yet or had been out of school for more than 24 months and therefore should not have received the invitation to participate.

Of the eligible respondents, the largest proportions graduated from either 18-month (or less) diploma (40%) or 2-year diploma (34%) academic programmes. Almost 20% graduated from a 3-year diploma programme with only 7% graduating from 3- or 4-year degree programmes (Fig. 1).

Of the study participants, 46% reportedly graduated from private institutions and 48% from publicly funded schools. For the majority (85%), the dental hygiene diploma was the highest level of education achieved. Two-thirds (66%) of the participants had 1 year or less time pass since their graduation, and the remaining had 1 to 2 years since graduation. Half of the participants were 20–25 years of age with the other half being either over 25–35 (41%) or over 35 (9.5%) years of age. The respondents were predominantly (96%) women. Half of the respondents were currently practicing in Ontario, and 19 and 16% were currently practicing in BC and Alberta, respectively. The remaining provinces had approximately 15% of the overall representation.

Use of ultrasonic instruments

The participants reported seeing a mean 6.2 (SD = 2.06) adult clients per day and 1.6 (SD = 1.19) child clients per day in



Fig. 1. Dental hygiene academic preparation.

practice. For every 10 clients treated, the respondents reported using ultrasonic instrumentation on a mean 6.4 (SD = 2.73) clients. Overall, the participants reportedly use ultrasonic instrumentation 53% of the time when compared to hand instrumentation.

For calculus and stain removal in clients with moderate to heavy deposit, 81.5% of study participants reported using ultrasonics 'all or most of the time', whereas only 15.2% reported using ultrasonics with these clients 'about half the time' and about 3% reported using ultrasonics 'less than half the time' or 'almost none or none of the time'. However, for those clients with light deposits, a reverse pattern was observed with 19% reporting using ultrasonics 'all or most of the time' and almost 40% using it 'about half the time' and 43% reported using ultrasonics 'less than half the time' or 'almost none or none of the time'. For biofilm removal, about 30% reported using the ultrasonics 'all or most of the time', 30% reported using 'about half the time', just over 40% reported using 'less than half' or 'almost none or none of the time' (Fig. 2).

Several other factors appeared to influence the use of ultrasonic instruments by study participants to varying degrees. These included deposit location (73%), patient tolerance (69%), client preference (68%) and soft tissue bleeding (47%).

Of the study participants, the majority (75.1%) reported using magnetostrictive ultrasonic instruments, whereas only 38% reported using piezo-powered instruments. Of those using magnetostrictive instruments, straight, slim inserts (i.e. Fig. 3a) were most commonly used as compared with traditional, thick (i.e. Fig. 3b), curved (i.e. Fig. 3c) or specialty-type inserts (i.e. Figs 3d and 4).

Of the respondents using the piezo-powered instruments, similar findings were reported surrounding the types of inserts used (Fig. 5).

Perception of preparedness of ultrasonic instrumentation

When study participants were asked about the timing of the introduction of ultrasonic instrumentation in their curriculum, the majority (69%) of respondents felt it was 'just right',



Fig. 2. Use of ultrasonics according to deposit (%).



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Fig. 3. (a-d) examples of insert-types diagrams. Reproduced with permission by DENTSPLY International, Dentsply Canada Division.

whereas 22% found it to be too late, and conversely, only a few (2%) found it to be too early.

New graduates were asked about the amount of practice time they had with ultrasonics after it was first introduced in school (preclinic) but before they used it in regular client care in the school clinic. Almost half (48%) felt they received just the right amount of practice time, and an equal proportion felt that they received too little practice time. Only a few (<1%) felt they had too much practice time. Most of the practice time was reportedly with classmates and patients (Fig. 6).

Once study participants began using ultrasonics in the clinical environment, there was reportedly not a strong requirement to continue using ultrasonics in client care (Fig. 7). Specifically, 57% of respondents were 'only sometimes' or 'not at all' required to use ultrasonics once in the clinic delivering client care. However, most study respondents reported that the theoretical component of their ultrasonic education was reinforced in the clinic with 25% reporting 'completely', 41% saying 'mostly' and 31% indicating 'somewhat', whereas only 3.1% reported that ultrasonic theory was 'not at all' reinforced in the clinic. When asked about faculty calibration, 22, 40 and 33% of study respondents reported that faculty were 'completely', 'mostly' and 'somewhat' calibrated in ultrasonic



Fig. 4. Magnetostrictive insert use (%).



Fig. 5. Piezo-powered insert use (%).

instrumentation clinical teaching, respectively. In addition, most of the new graduates found ultrasonic instrumentation equipment to be fully accessible (Fig. 8).

Study participants were also asked about their perceived level of overall preparedness in comparison with hand instrumentation. Half of all respondents felt that they were 'similarly prepared' (49%) to hand instrumentation, and 15.5% felt that they were 'more prepared'. However, more than one-third of study subjects were either relatively 'less' (28.2%) or 'much less' (7.3%) prepared in using ultrasonic versus hand instruments.

Regarding specific characteristics surrounding ultrasonic instrumentation preparedness, 'mostly very well' and 'mostly well' levels of preparedness were revealed for all aspects with only high volume suction being identified as a specific challenge (Fig. 9).

When asked about specific levels of perceived preparedness surrounding insert-type adaptation, much higher levels of preparedness were reported with 'straight' versus 'curved' inserts



Fig. 7. Requirement for ultrasonic use in clinic (%).

(Fig. 10). In fact, over 80% of the new graduates reported being 'very' or 'mostly' prepared in using straight instruments compared with just over half (53.4%) being 'very' or 'mostly' prepared with the curved instrument inserts. Study participants were also questioned about their perceptions surrounding confidence in using ultrasonic instrumentation with various deposits types. Participant confidence was reportedly strong when encountering all deposit types with the exception of subgingival calculus, which revealed slightly lower levels of confidence (Fig. 11).

Study participants were questioned on an overall level about their general feelings surrounding their perception of preparedness using ultrasonic instrumentation. The majority of the new graduates (87%) felt they were at least 'reasonably well prepared' at graduation (Fig. 12). The study also aimed to determine the participants' level of confidence in using ultrasonic instrumentation and if their confidence level was associated with their use of ultrasonics in practice once they graduated. Participants indicated having primarily moderate to high levels of confidence, which appeared to be associated with greater use in practice, and, to a lesser extent, did not affect use in practice (Fig. 13). While the group with low levels of confidence was relatively more associated with reduced use in practice, overall they largely increased use.

Not at all Somewhat Mostly Completely



Fig. 6. Ultrasonic practice mode (%).

Fig. 8. Ultrasonic instrumentation clinical education (%).

Instructor

calibration

Accessibility

Theory reinforced

100%

90% 80%

70% 60%

50% 40%

30% 20%

10%



Fig. 9. Level of preparedness: specific characteristics (%).

Relationships between perceived preparedness, use and confidence

The primary outcome measures, participants' level of preparedness, level of confidence and impact on use of ultrasonic instruments, were tested for relationships with various independent variables. Such calculations allow for explorations around relationships between curricular characteristics and desired educational outcomes. Independent, or predictor, variables were selected based on the hypothesis that they have an influence on these outcomes. Pearson's chi-square and the Kruskal–Wallis tests were used to test the significance of the bivariate associations, with the Pearson's test used when both variables were categorical, and the Kruskal–Wallis test used to compare distributions of a continuous variable between categorical groups. A *P*-value of ≤ 0.05 was required for statistical



Fig. 10. Level of preparedness: insert-type adaptation (%).



Fig. 11. Level of confidence with deposit type (%).

significance. It should be noted that many of the questions had many levels of analysis resulting in empty or sparsely populated cells in the table impacting the validity of the test and significance.

The type of dental hygiene programme one graduated from was hypothesized to be a key predictor variable for the outcome measures. While all programmes were found to produce graduates with reasonably high perceptions of preparedness in ultrasonic instrumentation, the 3-year diploma programme demonstrated the highest proportion of 'extremely well' or 'well' levels of perceived preparedness (P = 0.6962; Fig. 14). Findings surrounding confidence in using ultrasonic instruments in relation to programme type were mixed. While shorter programming was most associated with the highest proportions of confidence, moderate perceptions of confidence were most associated with the 4-year degree programme and the lowest levels of confidence were found to have small proportions (<20%) in all programme types (P = 0.2716; Fig. 15).

With respect to new graduates' level of perceived preparedness in using curved ultrasonic inserts, overall 46% were reportedly 'not very' or only 'somewhat' prepared. In relation to their programme of graduation, the 4-year degree programme had the largest proportion of graduates feeling less prepared (74%) compared with 52% of the 2-year diploma graduates, 42% of the 18-month diploma graduates and, finally, 35% of the 3-year diploma graduates (P = 0.1978). No differences were found in cross-tabulations comparing programme



Fig. 12. Level of ultrasonic instrumentation preparedness at graduation (%).



Fig. 13. Confidence level in ultrasonic instrumentation and association with use in practice (frequencies).

type and use of magnetostrictive versus piezo instruments or of curved instruments (P = 0.2252).

Study participants were asked about use of ultrasonics for biofilm/plaque removal. Overall, almost 20% reported that they use ultrasonics for this purpose 'almost none' or 'none of the time' with a range across programme type from 24% (18-month programme) to 9% (4-year degree programme; P < 0.05). For calculus and stain removal with clients presenting with light deposits, greater utilization of ultrasonics was demonstrated with about 16% reporting using ultrasonics 'almost none or none of the time'. Underutilization was fairly consistent across programmes, with all groups falling within the 17 to 14% range (P = 0.6644).

The perception of confidence in relation to use of ultrasonic instrumentation at graduation was also investigated. Very similar proportions of those using ultrasonics (50–57%) in practice were found across programme type. Only a small proportion of



Fig. 14. Programme type and level of preparedness.

the respondents (6%) reported having lessened their use of ultrasonics in practice as an outcome of their confidence levels, whereas almost 70% reported having increased their use due to their feeling of confidence. Of this latter group, 26% had high, 63% had moderate and 11% had low levels of confidence. For those who reportedly had low levels of confidence in using ultrasonics, almost 70% reported that their confidence level increased their use in practice, while only 22.5% decreased their use in practice (P < 0.001).

Predominantly large proportions of graduates from all programme types reported 'very high' or 'high' perceived confidence in using ultrasonic instrumentation for supragingival deposits (P = 0.9891). Confidence was slightly more moderate with subgingival deposit instrumentation, particularly with subgingival calculus removal, as graduates from all programmes reportedly being 'fairly confident' in subgingival technique.

Regarding the timing of the introduction of ultrasonic instrumentation education, about 70% reported it being 'just right', whereas <25% of graduates from most programme types reported that the timing was 'too late'. A slightly larger proportion of graduates from the 4-year degree programme reported the introduction being too late (30%). Although it was a very small overall proportion, those participants who felt the introduction of ultrasonic instrumentation was 'too early' reported the highest levels of preparedness (P = 0.9267; Fig. 16).

Specifically, of those respondents who felt that the introduction of ultrasonic instrumentation was 'just right', 29% felt that they were 'extremely well prepared' at graduation and 65% felt being 'reasonably well prepared'. Whereas those who felt the introduction was 'too late', only 8 and 59% were 'extremely well prepared' or 'reasonably prepared', respectively. Of those who felt the introduction of ultrasonics was 'too early', 43% were 'extremely' or 57% 'reasonably well prepared' (P = 0.9267). While less dramatic, similar results were demonstrated with the timing of the introduction of ultrasonics and the level of preparedness with curved instruments.

Similarly, higher levels of perceived confidence were reported in those groups who felt that the introduction of ultrasonics education was 'too early' and 'just right' than compared to those who found it to be 'too late'. However, perceptions on the timing of ultrasonics introduction did not have an impact on subsequent use in practice after graduation, which was similar in both the 'too late' and 'just right' groups (P < 0.0001).

In congruence with the timing of ultrasonic instrumentation introduction, increased practice time was associated with feelings of higher levels of preparedness at graduation in comparison with perceptions of 'too little' practice time, which were associated with feelings of being less well prepared. Those who felt they received just the right amount of practice time had perceptions of preparedness falling between the two other groups (Fig. 17). 'Too much' or 'just right' amounts of practice time were also related to higher levels of preparation in comparison with hand instrumentation, which contrasted to those who perceived having 'too little' practice time (P < 0.0001).



Similar findings were revealed when examining practice time and preparedness using curved instruments (P < 0.0001).

In addition, similar results were demonstrated with a perceived high amount of practice time and high levels of confidence in using ultrasonic instrumentation at graduation (P < 0.0001). However, all graduates reported a similar lack of impact on use of ultrasonics in practice after graduation regardless of one's perceptions surrounding amount of practice time. In fact, as an outcome of practice time, all three groups reported use was increased in practice, or to a lesser extent did not affect use in practice. Only very small proportions reported lessening use in practice in relation to practice time (P = 0.5249).

Discussion

dence.

This study provides insight surrounding recent dental hygiene graduates' experience with ultrasonic instrumentation, which to the authors' knowledge has not been investigated in a comprehensive manner previously. Specifically, the aim is to understand new graduates' perceptions about their use and

level of preparedness in ultrasonic instrumentation as an outcome of their dental hygiene educational experiences. Conducting the faculty survey simultaneously permits a detailed and reliable investigation into how dental hygiene curriculum shapes the new graduates' perceptions and will be reported on in a later paper. Together, this information will inform future dental hygiene ultrasonic instrumentation curriculum.

One study limitation was the small sample size. Survey studies increasingly suffer from low response rates. Given that this study used a census, no sample size calculation was used. The response rate was 26%, which appears to fall within a range not uncommon for survey research.

A second potential limitation in this study is the reliance on self-reported data. While self-reported data can suffer from inaccuracies, these are usually most pronounced when asking about socially sensitive issues and manifest as social desirability response bias (20, 21), which was not expected to be problematic in this study given the neutrality of the survey topic. In addition, given that the study aim is to investigate participant perceptions, respondents' self-reports are appropriate. Self-reported data can also suffer from recall bias, and to





Fig. 17. Perceptions of practice time and levels of preparedness.

minimize this, the study was limited to dental hygienists who graduated within a 2-year period. Additional future work studying actual performance and utility in ultrasonic instrumentation is warranted. This being said, the faculty survey should help ground the current findings by providing actual curricular information in relation to the graduates' perceptions surrounding use and preparation in ultrasonic instrumentation reported on in this study.

The study sample was not tested for representativeness of the overall dental hygiene population because this study was a distinct sample of new graduates. Still, both the proportion of female participants and the geographical make-up of the study group appeared to be representative of the overall dental hygiene population in Canada. There was, however, a slightly larger proportion of respondents from Ontario in this study in comparison with a recent CDHA employment survey, but the latter had a larger proportion of non-respondents (22).

It was interesting that almost half of the study participants graduated from shorter programming (18 months or less) that have been typically offered in private institutions. This may be because the last several years had an increase in the number of private schools offering abbreviated dental hygiene programmes particularly in Ontario and B.C, but this type of programming is now in decline in Canada. Typically in Canada, 18-month programmes refer to diploma granting private dental hygiene programmes, whereas 2-, 3- and 4-year programmes occur in publicly funded community college or university settings offering diploma or degrees. While the contact hours of these various programmes differ to more or less of an extent, there is also a lack of knowledge surrounding the quality of private institutional programming in comparison with publicly funded schools.

Use

Patterns of ultrasonic instrumentation use were found to be fairly similar across the different programme types. For all graduates, a much higher proportion of respondents reported using magnetostrictive ultrasonic instruments as compared to piezo-powered instruments, and there was no relationship between programme and type of ultrasonic instruments. Study participants reported using ultrasonics about half the time they are instrumenting with a more traditional style of use being evident.

This was evident in that the vast majority of respondents reported predominantly relying on ultrasonic instrumentation with moderate to heavy deposits versus those relying on ultrasonic instruments for light deposits. This was similar for biofilm removal with a much smaller proportion relying on ultrasonic instrumentation. This approach of using ultrasonic instruments predominantly for heavier deposits is not aligned with current ultrasonic technology and research, although study subjects from across the various programme types reported similar patterns of use.

This pattern of use also conflicts with the finding that the straight, slim insert type was the most commonly used insert. The traditional, thick insert would be the more appropriate insert choice for use with moderate to heavy deposits, suggesting that incorrect application of the technology may be wide-spread.

Further evidence of a more traditional approach to ultrasonic instrumentation was evident in that for both the piezo and magnetostrictive ultrasonic users, a much stronger reliance on straight inserts was reported, whereas curved and specialty inserts, such as implant, ultra-thin and diamond-coated inserts, were used much less. The curved inserts are specifically designed for subgingival root anatomy and furcations and are more adaptable to these environments. This was found across programme type with no relationship being shown between programme type and insert use and application.

This reliance on straight inserts could be an outcome of new graduates simply using ultrasonic instrumentation less in the subgingival area, which is aligned with a more traditional approach, or, alternately, study subjects are applying the straight inserts in subgingival area, which they are not well designed for. In the latter case, a lack of preparation in using curved inserts, and other specialty inserts, may be the explanation. It is feasible that this finding is a consequence of the level of proficiency associated with the neophyte dental hygienist or alternately reflects a gap between theory, education and practice. Results from the faculty survey will further explore this finding.

It should be noted that study participants were not asked in the survey about the availability of ultrasonic equipment in their respective practice. It is feasible that new, technologically current units and inserts are not available in study participants' practice settings. However, it is a dental hygienist's professional responsibility to use technologically sound equipment in an evidence-based manner (23). Therefore, all dental hygienists must ensure that such equipment is available in practice.

Preparation

Despite the apparent traditional approach in ultrasonic instrumentation being used at graduation, overall, the new dental hygiene graduates felt their education well prepared them for ultrasonic instrumentation in practice. All programme types yielded high proportions of graduates with perceptions of high levels of preparedness. The 3-year diploma programme had the highest reported levels of preparedness, and the 4-year degree programme had the lowest proportions of preparedness. Investigating the specific curricula of the different types of programmes may help elucidate why these differences are perceived. About half of the respondents felt similarly prepared in using ultrasonic instrumentation compared with hand instrumentation, but over a third reported being less or much less prepared. This is an area of potential further work to determine whether the discrepancy in preparation is an outcome of educational preparation and whether additional practice is necessary in ultrasonic instrumentation.

Corresponding with the findings surrounding use of straight versus curved instruments, a much larger proportion of study subjects reported feeling well prepared with straight versus curved inserts. Overall, preparedness was also better with instrumenting supragingival environments and with biofilm disruption than for subgingival calculus removal. This lack of perceived preparedness may help explain the reported traditional approach to ultrasonic instrumentation discussed previously. It is anticipated that the faculty survey will help determine whether the curriculum is in some way perpetuating a traditional versus contemporary approach in ultrasonic instrumentation.

With regard to the timing of the introduction of ultrasonic education, most study participants felt that the timing was appropriate. While a smaller proportion felt it was slightly late in the curriculum, this was more pronounced with the 4-year degree graduates. This may be due to the fact that their programming is longer overall and may more readily permit a delay in introducing ultrasonic instrumentation. This can be confirmed through the faculty survey.

Importantly, those that reported that the timing was too late had the highest proportions of those feeling poorly prepared and lacking in confidence. Conversely, those who reported that ultrasonic education occurred too early in the curriculum felt the most well prepared and the most confident. This finding may be important to promoting an earlier introduction of ultrasonic instruction into programme curricula. Perceptions on timing of ultrasonic education were not found to be associated with use in practice after graduation. The majority of study subjects reported that regardless of the perception of timing, whether too early, too late or just right, they reportedly increased their use of ultrasonics after graduation.

Similar findings were found surrounding practice time. Overall, almost half of the study subjects felt they did not get enough practice time with ultrasonic instrumentation prior to using it in routine client care. Practice with hand instrumentation is typically relatively extensive in the preclinical environment. This apparent discrepancy in practice time may be due to the challenge of practicing ultrasonics preclinically or may be due to a belief held by educators, legitimate or not, that hand instrumentation requires more practice or is more critical to client care and requires further investigation.

Interestingly, those who felt they had excess practice time reported higher levels of preparation and confidence, whereas those who reported a lack of practice felt poorly prepared and had lower levels of confidence. Like the timing of the introduction of ultrasonics, the amount of practice time was not associated with subsequent of ultrasonic use at graduation with all groups reporting increasing use. An explanation for why study subjects generally had increased their use of ultrasonics upon graduation, albeit in a traditional format, was not explained in this study and requires further exploration.

Surprisingly, the new graduates reported that there was little pressure to practice use of ultrasonics in the clinic once it was introduced into regular client care. These authors believe that this is likely an outcome of faculty philosophy and subsequent encouragement or reinforcement in the clinic. Further insight surrounding this finding may emerge in the faculty survey.

Encouragingly, study subjects reported the link between ultrasonic instrumentation theories was mostly reinforced in the clinical setting and that the faculty were well calibrated in ultrasonic instrumentation education. However, the study was not able to determine what points or philosophy of education this seemingly good calibration was based upon. Further, the study participants reported having good access to ultrasonic equipment. All of these factors would likely reinforce appropriate student use of ultrasonic instrumentation providing that the curricula reflected a contemporary ultrasonic approach, meaning that it is evidence-based and grounded in current research and technology.

Finally, new graduates had lower perceived confidence with both subgingival biofilm and subgingival calculus removal with ultrasonic instrumentation than perceived confidence surrounding supragingival deposit removal. Feelings surrounding confidence were similar across programme type. Findings regarding confidence in sub- versus supragingival deposit removal with hand instrumentation could reasonably be assumed to be similarly lower than with supragingival deposit removal. It is obvious that the subgingival environment presents additional challenges to instrumentation overall, which prompts the authors to consider current root anatomy education.

Regardless of the level of confidence in using ultrasonic instruments, almost three quarters of participants reported having increased their use as a result of their perceived confidence. It is important to note that confidence, while an important component in health professional work, is often highest in the least capable individuals and is not a good predictor of overall competence (24, 25).

It is unknown from this study why use increased in practice regardless of feelings of confidence, but it may be related to the faster pace of real practice environments as compared to educational settings, and/or the expectations of employers. It has been demonstrated in previous studies that debriding with ultrasonic instruments is faster than using hand instruments (26, 27). Additionally, in the practice environment, colleagues may encourage ultrasonic use. There may also be clinical parameters in the educational setting limiting ultrasonic use not present in practice, which can be further examined in the faculty survey.

Conclusion

This study reveals that new dental hygiene graduates perceive greater preparedness, confidence and subsequent use of ultrasonic instrumentation within a more traditional versus contemporary paradigm. These findings indicate that there may be an incorrect and/or inappropriate use of current technology, despite seemingly high levels of confidence of the new graduate. While strong differences between schools were not shown, graduates from the 3-year diploma programmes perceived having greater comfort in ultrasonic instrumentation overall and specifically with curved inserts. An earlier introduction in the curriculum and increased practice time in ultrasonic instrumentation were both associated, although demonstrated with small numbers, with increased preparation and confidence potentially supporting these features being emphasized in dental hygiene curriculum. Together, these findings raise concerns about ultrasonic educational preparation and question if it facilitates adequate preparation of dental hygiene graduates for using current ultrasonic theory specifically focused on new technology. Investigating the dental hygiene ultrasonic instrumentation curricula in the faculty survey will be critical in determining whether and how the traditional versus contemporary ultrasonic paradigm is being reinforced.

Clinical relevance

Based on the evolution in ultrasonic technology, the investigators aimed to determine whether dental hygiene curriculum is

40 | Int J Dent Hygiene 13, 2015; 30-41

based on a contemporary approach and whether new graduates perceive being prepared and use ultrasonic instruments within contemporary formats. It appears that new dental hygiene graduates primarily use ultrasonic instruments in a traditional manner, meaning primarily with heavier deposits, but, conversely, rely on slim, straight inserts. Investigators concluded current ultrasonic technology is not used optimally. Phase two of the study will investigate whether this is an outcome of the curriculum or other influences.

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Authorship

Each of the following authors contributed to this research by '(1) making substantial contributions to conception and design of, or acquisition of data or analysis and interpretation of data, (2) drafting the article or revising it critically for important intellectual content and (3) final approval of the version to be published. This was a true collaborative effort' (IJDH, 2014).

The Principle Investigator (PI), Dr. Joanna Asadoorian, was recruited to lead the project. She was responsible for developing the ethics submission and obtaining ethics approval, developing the survey instrument, managing and interpreting the data and writing the first draft of the manuscript with the exception of the introduction. She provided guidance for the research process throughout its entirety.

Ms. Dani Botbyl was responsible for generating the initial idea for the research, developing a timeline and budget, raising financial support, recruiting the research team and coordinating the research project. She also coconducted the literature review and cowrote the first draft of the introduction. In addition, she took part in the research by providing input into all phases of the study including the development of the survey instrument, interpretation and review of the manuscript.

Professor Marilyn Goulding was recruited by the study coordinator to participate in the study. Professor Goulding coconducted the literature review and cowrote the introduction. She also took part in the research by providing input into all phases of the study including the development of the survey instrument, interpretation and review of the manuscript.

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